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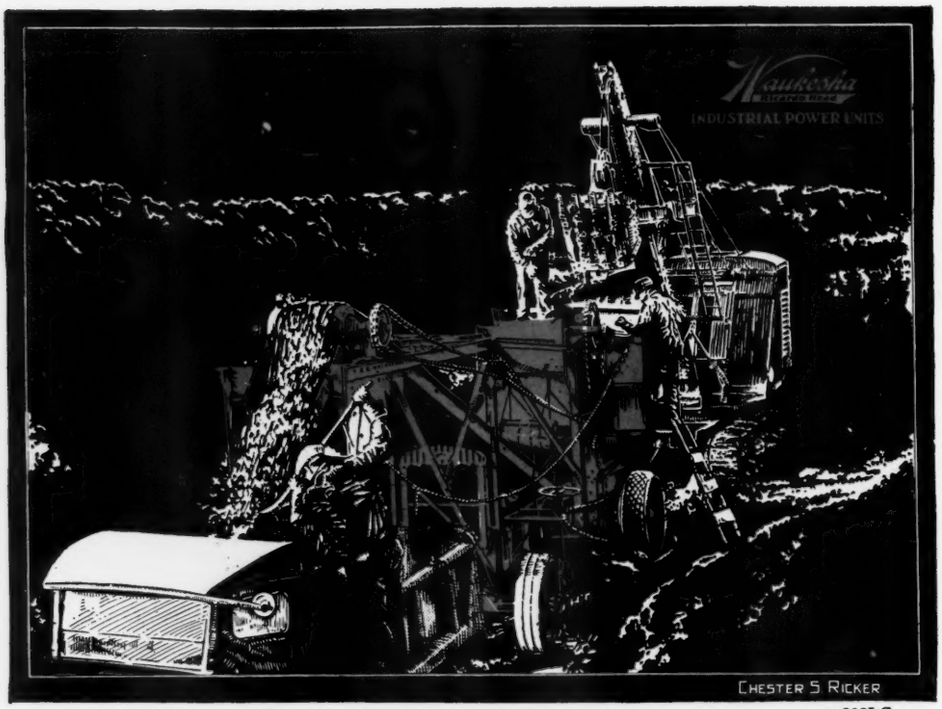

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FEATURE CONTENTS

Farm Bankruptcies Decreasing 45

Solving a Gypsum Quarry Problem 49
A descriptive article concerning some problems at Fort Dodge, Iowa.

Flotation of Low Grade Phosphate Ores 54

Comparative Tests of Crushed Stone and Gravel Concrete in New Jersey 55

A Voucher System and Its Advantages..... 67
J. J. Berliner presents some practical suggestions.

Some Interesting Experiments with Gypsum 72

National Building Industries Project Home Modernizing Bureau 77

An Efficient Substantial Plant Pays North Lake Sand and Gravel Company .. 79

Dust Collectors In the Pit and Quarry Industries 85

Variation in Adsorption of Asphalt by Different Mineral Aggregates 88

Pit and Quarry Foreign Digest 91

Intimate News of Men and Plants 93

News of Equipment Manufacturers 101

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Pit and Quarry

Vol. 16 CHICAGO, ILL., APRIL 11, 1928 No. 1

FARM BANKRUPTCIES DECREASING

FARM bankruptcies in the United States declined sharply in 1927, although the proportion per thousand farms remained much higher than before the war. Figures compiled by the United States Department of Agriculture show that the bankruptcy rate in 1927 was .99 per 1,000 farms, compared with 1.22 in 1926, 1.23 in 1925, and 1.22 in 1924. The number of farm bankruptcies per thousand farms in 1913 was only .15, or slightly more than the average for the decade 1905 to 1914.

After the war the farm bankruptcy rate increased nearly tenfold. Indeed, an increase in farm bankruptcies was noted even during the war. In 1917 the number per thousand farms was 0.30, or more than double the number before the war. A decline nearly equal to the pre-war average took place in 1919 and 1920. Thereafter, however, the rate jumped. From 1924 to 1926, inclusive, it reached an average of 1.22 per thousand farms.

Apparently the decline in 1927 indicated an approaching end of the abnormal wave of bankruptcies made inevitable by the losses of the postwar agricultural crisis. This does not imply that no improvement in agricultural conditions had been made prior to 1927. Slow recovery began, in fact, as early as 1922. But changes in agricultural conditions are not reflected immediately in the rate of farm bankruptcies. It usually takes several years for prosperity to reduce, or depression to increase, the farm bankruptcy rate.

In other words, the numerous farm bankruptcies of the last three or four years are a delayed reflection of the depression of 1921-22. In like manner the decline in the bankruptcy rate in 1927 may be considered evidence both that the job of clearing away the wreckage of the depression period is nearing completion, and also that the last few years have been on the whole a period of agricultural recovery.

Farm bankruptcies do not fully reflect the financial difficulties of agriculture. The number of farmers who resort to the bankruptcy courts is relatively small, even in hard times. A survey based on 69,000 owner farmers and 26,000 tenant farmers in 15 States of the Middle West for the period January, 1920 to January, 1923, showed that the proportion of financially distressed farmers who lose their property without foreclosure or bankruptcy is larger than the proportion who lose it through such proceedings. Moreover, many insolvent farmers retain their farms through the leniency of creditors. Thus, the fact that the rate of business bankruptcies is much higher than the rate of farm bankruptcies is not a measure of relative farm and business conditions.

Farm bankruptcy statistics are nevertheless a valuable indication of general and also of local agricultural changes. It is significant, for example, that some of the States where the bankruptcy rate was heaviest from 1923 to 1926 had the sharpest decline in the rate in 1927. This is true of the Northwest States, which showed the greatest increase in bankruptcy in the postwar depression period. On the other hand, regions like the States east of the Mississippi and the Cotton Belt west of the Mississippi, which had the lowest postwar bankruptcy rate, experienced the least change in the rate last year. Generally speaking, the middle general farming States, the dairy States (except Maine), the Cotton States (except Georgia), and the Corn Belt (except Iowa), had a lower bankruptcy rate in the depression period than the States farther west. They are now experiencing a more gradual decline in the rate. Where the wave rose highest it has fallen most.

Thus in Maine, whose farmers depend largely on cash income from the highly variable potato crop, the bankruptcy rate from 1924 to 1926 was more than 2 farms per thousand. The decline last year carried the rate down to 1.02. That showing contrasts sharply with the figures for Kentucky, West Virginia, Virginia, Maryland and Delaware, a region in which the postwar depression produced relatively fewer bankruptcies than in some other regions. The rate in that region in 1926 was 0.49, and in 1927, 0.53 per thousand farms.

A similar contrast is afforded by a comparison of the Southwest with the Northwest. In Arkansas, Louisiana, Oklahoma, and Texas the rate dropped only from .75 in 1926 to .56 in 1927. In Montana, North Dakota, South Dakota and Wyoming the rate dropped from 7.19 to 4.61. In Ohio, Indiana and Illinois the rate dropped from .80 in 1926 to .71 in 1927, whereas in Oregon, Washington and Idaho a bankruptcy rate of 3.03 farms per thousand in 1926 was cut down to 2.31 in 1927.

Areas of unusually numerous farm bankruptcies

in recent years, the department notes, have also been areas of unusually numerous bank failures. In the six years of 1920 to 1925, about 64 per cent of all bank failures occurred in 10 agricultural States—Montana, North Dakota, South Dakota, Minnesota, Nebraska, Iowa, Missouri, Oklahoma, Texas, and Georgia. These States in the 20 years from 1900 to 1919 had only 23 per cent of the bank failures occurring in the country.

The areas of relatively numerous farm bankruptcies in recent years have not necessarily coincided with the areas where land values rose abnormally during 1919 and 1920. Thus in Georgia, where land values in 1920 reached 218 per cent of their pre-war average compared with 169 per cent for the country as a whole, the number of farm bankruptcies has not been proportionately greater than in Oregon, Washington and Idaho, where land values rose only 43 per cent. Farm bankruptcies in Iowa, where land values in 1920, rose to 213 per cent of the pre-war average, were relatively large. But in the four States where farm bankruptcies were most numerous, namely, North Dakota, South Dakota, Montana, and Wyoming, postwar increases in land values amounted to only 58 per cent of the pre-war average.

The Department of Agriculture index of the general level of farm prices advanced during the period February 15 to March 15, from 135 to 137 per cent of the pre-war level, the advance of two points being accounted for by a general but moderate advance in most of the commodities included in the index. Only three commodities listed declined during the month, eggs, hogs and hay, the most significant decline being in eggs which was largely seasonal. Hog prices have followed a downward trend for several months, while the decline in the farm price of hay has had a general downward trend since the harvesting of last year's large hay crop. At 137 the index is 11 points higher than on March 15 a year ago.

Apparently financial difficulties in agriculture since the war, says the department, have been associated not with abnormal advances in land values alone, but also with uncertain, highly variable, and generally depressed farm receipts and with the persistence of relatively high and inflexible costs of production on the farm.

WHY NOT WATCH MEXICAN LABOR?

ONE of the principal arguments used by those in favor of extending the quota law to include Canada and Mexico, which proposed legislation is slated for discussion in the near future before the Immigration Committee of Congress, is that inasmuch as the quota law now applies to Europe there is no good reason why it should not also apply to the nationals of the western hemisphere. This argument while feasible enough at first glance does not appear so convincing when subjected to closer examination.

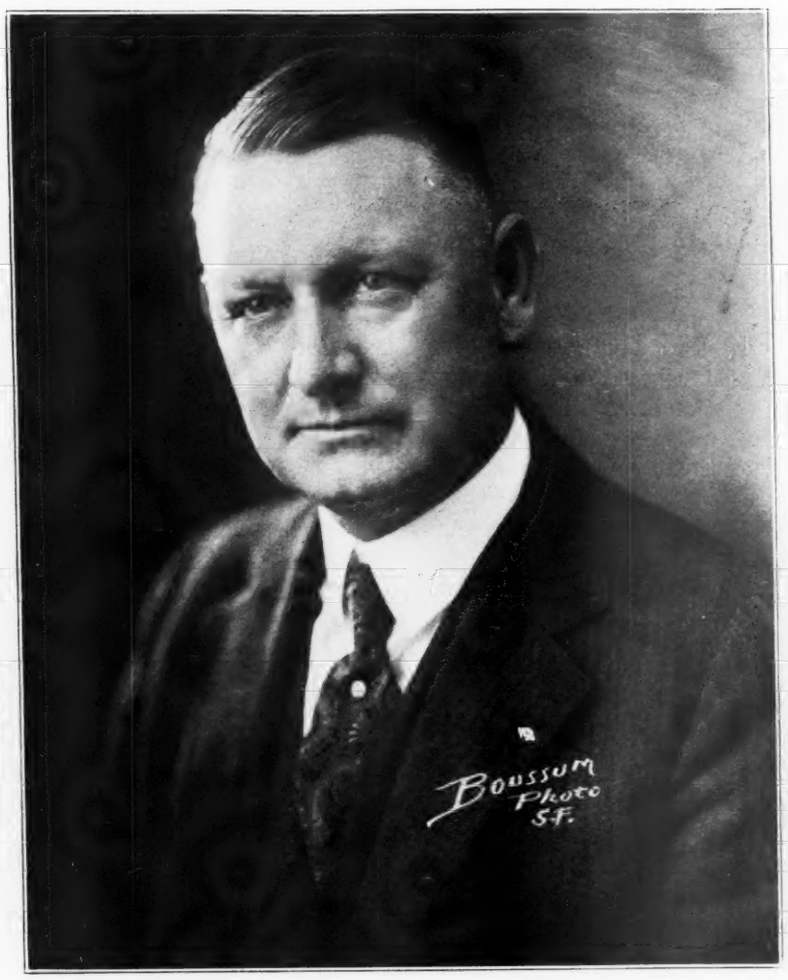
The quota law, as applied to Europeans, shuts out yearly millions of people who are seeking to come to this country to make a permanent home, a majority of whom are today unnecessary to the welfare of the nation and even, in many cases, a direct detriment to it. It selects those who are to be admitted and applies a more strict test as to their fitness for entry than was previously possible. The European immigrant, when he comes to America, comes to stay. He has crossed the ocean and, generally speaking, has burned his bridges behind him.

But the situation when applied to Mexico is entirely different. The Mexican farm laborer when he comes to the United States does so in order to be here during the seasonal periods when his services are essential to the agriculturists of the Southwest and to earn the few dollars which, to him, are a princely sum. This done he goes back to enable him to settle down in his own community as a man of some means. He has no ocean to cross—no long road ahead of him. He is practically home before he starts and one of the reasons he has come to the United States, in which he has little or no desire to remain, is that it is so close at hand both to get into and out of.

Government officials admit that their figures, both as to the entry and departure of Mexicans into this country are incomplete and, consequently, inaccurate. The best figures obtainable from the most reliable sources state that 80 to 85 per cent of the Mexicans who annually enter the United States return home. There is, therefore, a considerable difference in the matter of the necessity for a quota on Mexico as compared with Europe. It is also to be remembered that the agricultural labor furnished by the Mexican is an absolute essential if the Southwest is to expand, agriculturally or otherwise. The great Southwest today is at the same stage of its development as was the East and Central West at the time when only the labor which came from Europe opened up the country, built the railroads, cleared the land and, in brief — made America. Today the same East is thickly populated. Today the Southwest must still bring in its labor to harvest the great agricultural crops that the East demands. And this particular type of labor cannot be supplied by the populated East. White men cannot, and would not if they could, perform this class of work under the climatic conditions involved. The Mexican today is as essential to the development of the Southwest as was the European of yesterday to the development of the East and Central West.

MEN OF THE INDUSTRY

The portraits printed on this page in each number of PIT and QUARRY are taken from our files and their selection is without significance as to current events or as to the position of the individual in the industry.



Clarence F. Pratt

Mr. Pratt is President of the
Pratt Building Material Company
of San Francisco, Calif.

SOLVING A GYPSUM QUARRY PROBLEM

WE have a gypsum deposit twenty feet thick and covered by a forty-five foot overburden. To quarry this and get it out cheaper than by underground mining methods was the problem which the engineers of the United States Gypsum Company solved in a very successful manner at their Fort Dodge operation.

Why not mine it by underground methods? This is a natural question. The answer is that gypsum deposits having the purity and wonderful economic location, that this one has, are not plentiful. The United States Gypsum Company, knowing there will be a time when the best deposist will be worked out, chose to adopt methods which would give the greatest life and ultimate output from this choice deposit. Underground mining gives only about 50 to 60 per cent extraction at a reasonable cost. Even though this cost was low the company saw that careful selection of the very most up-to-date quarry equipment and methods it could not only produce gypsum rock at a lower cost than ever done heretofore but also get practically 100 per cent extraction of the rock in this particular section of the deposit.

The part of the deposit chosen for the quarry is about three hundred acres lying to the west of the plant proper and extending southwards. It practically takes a half section of ground and at present the haul to the crushing plant and mill is a little more than half a mile. The present operations are confined to the south half of the half section.

The quarrying operations fall naturally into three divisions, i. e., stripping, final cleaning of the rock surface, and quarrying proper. At this time, the top surface of the rock is in no way flat or even approaching it. It is very thoroughly cut up with fissures and crevices. The typical cross section of these fissures generally resembles a "V", the bottom part extending down into the rock as a rule from a couple of feet to seven or eight feet. These of course are filled with clay. The overburden is all clay and loam with no hard bands or rock.

Stripping

The stripping operation consists in excavating the dirt and hauling it away to waste dumps to the south and west of the quarry. The average production per 10 hour shift is about 2500 yards.

Excavation is handled by a 300 Marion electric dragline excavator. The machine is equipped with a six yard Page bucket and has a 150 foot boom. In common with all large shovels it has the very convenient Ward Leonard control. It is one man operated. The only other man necessary besides the operator is an oiler.

The machine sets on short rail sections of 130 pound rail. These in turn set on sturdy timber mats. These mats are made of two layers of 8 by 8 timber, bolted together to form a mat about 16 inches thick, 6 feet wide and about 12 feet long. A heavy ring and eye bolt make it an easy matter for the oiler to hook a cable to the mat and bucket chains. The shovel operation then places the mats in position with the machine power. It is possible for the operator and oiler to get the mats in position and move the machine about 18 feet in one-half hour. These moves of the machine are usually done at noon hour or between shifts.

The dirt is excavated by the dragline and dumped into cars which are hauled to the dirt dumps. There are twelve sixteen-yard side dump cars used for this purpose. Koppel cars are used, they are air dumped and equipped with standard Westinghouse air brake equipment. All haulage equipment runs on standard railroad gauge track. Three twenty-eight ton Vulcan saddle tank locomotives are used for haulage.

The dirt dump conditions at this operation are such that there is much track shifting necessary. This is done by two Nordberg track shifters. These machines replace the large track gang ordinarily required for shifting. The Nordberg unit consists essentially of a steel framed car on which is mounted a 40 horsepower, four cylinder, completely enclosed gasoline motor together with the necessary drives and controls for operating the worm and gear driven spud which supplies the lifting action. The machine is self propelled and will operate in either direction. It has two speeds, a low of 7 miles per hour and a high of 22 miles. The dumps are of the side hill type, they generally are started on the edge of a ravine (there are several ravines within a half mile of the strip pit). As soon as the dumps are filled by dumping dirt on the down hill side a Jordan spreader car is pushed in by one of the locomotives and the dirt in this manner is leveled off. The track shifters then shift the track to the edge again ready for more dirt. Owing to the topography of the ground and the frequence of slides on the dumps it is necessary to have at least three dump tracks, four are better. The average dumping length of one dump track would be about 400 feet and the average height about twenty-five or thirty feet. This size of a dump will only hold a half shift run or about 1200 yards of dirt. As it takes about one half a shift to prepare a track to dump on again after it is once full one can see the necessity of having several tracks.

Slides are very frequent and a dead certainty if any quantity of the dumped material is wet or sloppy. These slides will often drop the track for

The Track Shifter

from five to twenty feet in the space of fifteen minutes or one-half hour.

A slush dump or wet dump was tried with some success. This is simply a dump on a side hill where the track is kept on solid ground and the dirt dumped as usual except that a stream of water of about 150 to 200 gallons per minute is played on the fresh dirt. This so lubricates the material as to cause it to slide to the foot of the hill. Twenty-five thousand yards of dirt were disposed of on one dump track in this way without once shifting the tracks. It is much more difficult however to keep the dumped material within definite boundaries by this method.

Cleaning the Rock Surface

As mentioned earlier in this article the surface of the gypsum deposit is very rough and irregular, resembling on a very large scale the top of a dish of hot biscuits. (The kind mother used to make.) The fissures or valleys in the rock of course are filled with clay. Hydraulicking methods are used to clean out these fissures, a multistage centrifugal pump pumps the water from a storage sump through an 8-inch American Spiral riveted pipe to a hydraulic giant. This pump supplies 1000 g.p.m. at 150 pounds pressure. The water is played on the surface of the rock by using the fissures to the best advantage. The dirt and clay is washed to temporary sumps from which it is pumped out of the quarry by a dredge pump. Perhaps this seems at first sight a rather roundabout way of getting rid of the dirt filling the irregularities in the rock, but when it is realized that there is no natural drainage from the quarry, that the dips, fissures, "vugs", and other irregularities go down from three to ten feet into the rock, and the general surface is such that a team could not pull a wagon over it; it can be seen the problem is an unusual one.

The hydraulic method of cleaning has not proved entirely satisfactory however. This is due to the impossibility of using it in winter months, and to the fact that gravel and boulders settle out into the bottom of the fissures and have to be removed by hand. It is very necessary that gravel and boulders do not get mixed with the rock, as they cause much trouble later on and make it impossible to produce a fine and even grind in the mill.

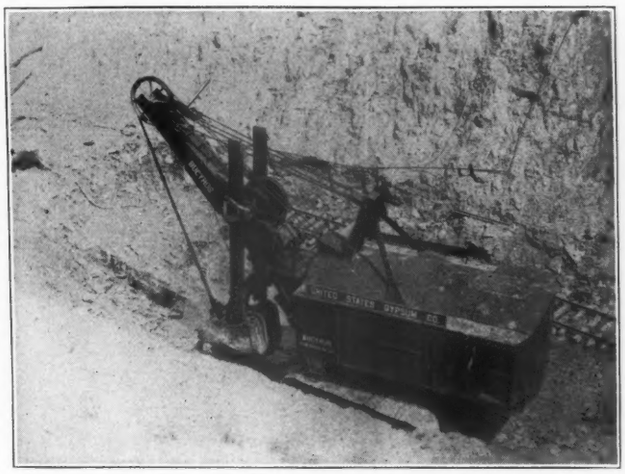
A Portion of the Gypsum Quarry

Rock Quarrying Proper

The rock gypsum itself is quarried in one bench. Primary drilling is done by a Denver Number 21 drill mounted on a light derrick rig. Holes are drilled vertically about twenty to twenty-five feet deep and usually about 18 inches short of the depth of the rock. Owing to the numerous vertical slips the rock tends to break up in large chunks. It has been found economical to space the holes close together (6 to 8 feet) and load not too heavily. The charge is often split up into two or three decks and the whole set off with Cordeau Bickford detonating fuse. The explosive used is one of the Dupont special dynamites. Experiments are being tried with the F. G. and H. grades. Secondary breaking is done by block holing and by an Ingersoll Rand paving breaking. Holes for blockholing are drilled by an Ingersoll Rand jackhammer.

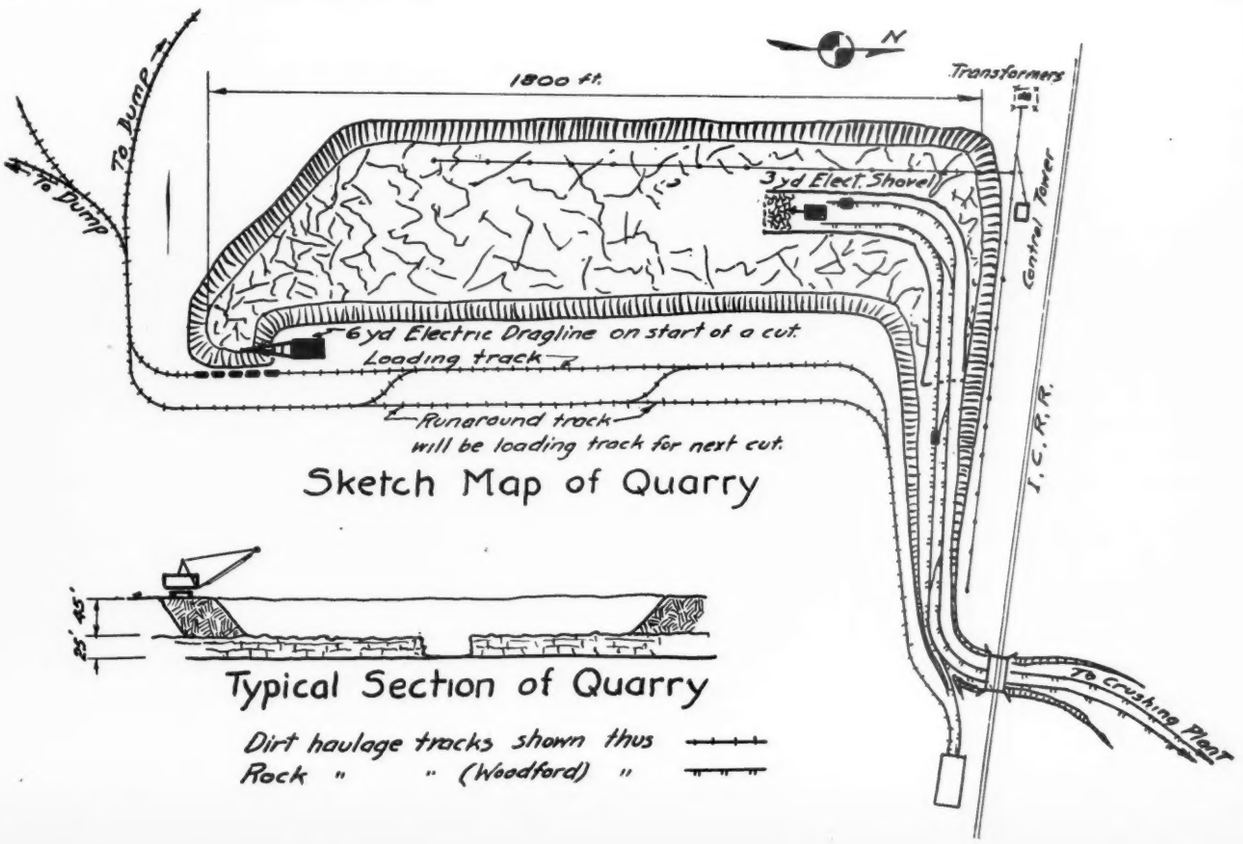
A Bucyrus 100-b Electric shovel is used to load the rock. This machine has a three yard bucket and the Ward Leonard control. It is caterpillar mounted and the full revolving type.

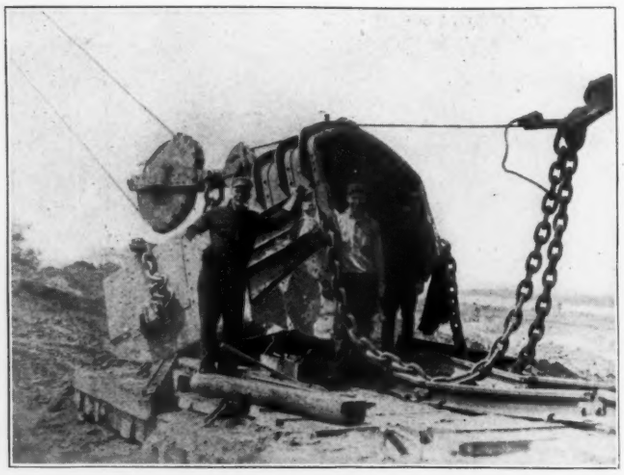
The haulage system used for the rock quarry is the Woodford Haulage system. This system consists of rock cars which have their own power units in the form of D. C. Motors, geared direct to the wheel axle. Power is delivered to these through a third rail. All the track on this haulage system has the third rail which however is sectionalized in such a manner that power is only on this rail when a car is made to move on this section. There is no one on these cars to control them. All movements and control of cars is done by two control



Shovel Loading in Quarry

tower men who by means of switches and controllers can move any and all cars in the pit or on the way to the crushing plant. The third rail may seem to be a dangerous thing however as the voltage carried is only 250 d.c., and the rail is normally "dead." It is not so awful as it might seem. By this system the control tower operator spots a car at the shovel and as soon as it is loaded starts it away. It then climbs a 6 per cent grade out of the pit to the ground level and after about a two thousand foot run is "picked up" by the other control tower operator (who is stationed in the crushing plant). He runs it up a 6 per cent incline to the crusher and by remote control dumps the car, and starts it back on its way to the quarry. It may seem unusual, but by using only four Woodford cars it is easily possible to send 1500 tons to the crusher





Close-Up of Dragline Bucket

in ten hours. Each car holds about twelve and one-half tons. As only two men are required to operate the haulage system, and one man for maintenance work on it, the economies can be seen.

It might be added at this point that the quarry is being developed by making a "Box" cut the full length of the stripped area. This plan will in a short time develop a long quarry face. The gypsum rock from the quarry is dumped into a McCully Superior Number 21 gyratory crusher. This crusher which is made by the Allis Chalmers Manufacturing Company takes rock up to 36 by 48 inch size and crushes it down to about 5 inch size. From this it is taken over a pan conveyor and magnetic pulley and delivered to a Jeffery swing hammer mill which breaks it down to pass through a two inch ring. At this point the crushed rock leaves the crushing plant on an inclined belt conveyor which puts it in a 1500 ton silo or out on a 25,000 ton stock pile. Rock from the silo and stock pile is reclaimed through a reclaiming tunnel onto a belt conveyor and elevated to the top of the screening and grading plant.

The Mill

The grading plant consists of two bins and one two deck Hummer screen. The purpose of the grading plant is to be able to supply to the Cement Industry carefully graded crushed rock. Such rock when desired is screened and put into a loading bin from which it is conveyed to a loading spout directly into the railroad cars. As only a small per cent of the rock is shipped to the Cement Industry the bulk of the rock goes without screening to the mill bins. This is a 1000 ton bin. From here it is fed into two rotary dryers which are kept to a heat of about 180 Fahr. by coke fires. These dryers take out the mechanically contained moisture (or wetness).

The dried rock is then elevated to two Jeffery swing hammer mills which pulverize the rock down to about ¼-inch size and under. This product goes to separators which take out the fines which will all pass through a 100 mesh screen. The fines go directly to the kettles. The coarse or +100 goes to the buhr mills. These are horizontal buhr mills, which grind the raw gypsum down to a fineness so that about 85 per cent passes through a 100 mesh screen. This product joins the air separator fines and is fed to the kettles. There are seven fifteen ton kettles. They are heated by hand firing. The calcining or cooking is a "batch" process. The raw ground gypsum after being spouted into the kettles is calcined or cooked. During this process it is agitated or rather stirred. A vertical rotating shaft carries arms which keeps the ground gypsum from sticking to the sides of the kettle. The cooking or calcining process simply consists in so heating the kettle and its contents that it is evenly brought up to a temperature of 250 Fahr. in one hour and a half. Experience has shown that this is the best temperature and time to do the calcining in. When the point is reached the kettle is dumped, actually the kettle is stationary, but the product, which is now Plaster of Paris, is allowed to run out of a spout at the bottom of the kettle.

The calcining simply is a process of driving out a certain per cent of the water of crystallization. Actually about 75 per cent of the water is driven off as steam. The chemical reaction is as follows: $2\ (CaSO_4 . 2H_2O) + \text{heat} = 2\ CaSO_4 . H_2O + 3H_2O$. This stucco or Plaster of Paris after being dumped from the kettle is held for a few minutes in hot pits or cooling bins. From these it either goes to two tube mills to be reground or is sent directly over to the board plant or block plant. The cement plaster to be used for plastering walls is all reground. However, some of the other varieties of plaster such as used in making partition block and roof tile are not given any further treatment in the mill proper.

The regrinding gives the plaster good working qualities which are a boon and a joy to the plasterer but are hard for the layman to understand.

The mill products are carried by screw conveyors over a trestle or highline to either the block plant, board plant, or warehouse. The warehouse is where the plaster is given the finishing touches.

Straight stucco from the mill if mixed with water will set up in about twenty minutes. In the warehouse the stucco is fed and conveyed from bins to Broughton mixers. In these mixers, to batches of about 1000 inches of stucco are added carefully weighed quantities of retarder and, according to the customers' desires, either hair fibre, sisal, wood fibre, or sand. Some customers prefer to have the plaster mixed with retarder only, and prefer to add other ingredients themselves.

The last operation is the sacking and loading. The sacking is done by Bates machines into either paper bags or jute sacks. The sacks are immediately trucked into the boxcars which are spotted on loading tracks on both sides of the warehouse. Only a very small per cent of the shipments are made by truck to a few local customers.

The modern and efficient block plant is equipped to make various sizes of partition block and roof tile. There are two block machines and a large hand moulding floor. The whole plant is of fire proof construction well lighted and ventilated. The board plant is equally well equipped with one of the largest board machines in the world and a smaller machine. The plant is capable of producing 500 thousand feet of board per day. Its products are "Sheetrock" in all standard sizes, "Rocklath" and "Gyplap."

It would not be out of place here to mention the fact that the most careful control is maintained over every step of all the processes, to insure the very best quality of products. Samples of the grinds are taken and tested several times per day. Tests are made on samples taken from each kettle batch. No car of plaster is allowed to leave without a test being taken and receiving the laboratory's approval. Blocks and boards are tested for dimensions and strength. Quality of product is kept to the highest at all times.

Uniform Municipal Building Code Agitated by Engineers

Antiquated building codes are making construction costs in many large cities unnecessarily high, Arthur R. Lord, president of Lord & Holinger, civil and architectural engineers, declared before a meeting of the Western Society of Engineers at Chicago. Lower rents, reduction in merchandise prices, and safer, more attractive buildings will result when municipal building codes are revised to recognize modern advances in construction science, he said.

Mr. Lord is a member of the new Chicago Code Committee, which is making a revision of the Chicago building code. Similar committees in New York and Philadelphia are working on the same code material and there is a prospect that uniform municipal building regulations may be adopted by all large cities. Many large cities are laboring under the same difficulties as Chicago because their building codes have not been revised for years and consequently prevent architects, engineers and contractors from taking advantage of recent developments and improvements in construction technique, Mr. Lord told the meeting of engineers.

"Chicago building ordinances were slightly revised in 1917, yet since that time many advances have been made in engineering which make construction both cheaper and stronger," Mr. Lord asserted. "But on these advances, our present code and similar ordinances in other cities, are silent. If they were incorporated into and recognized by the codes, building costs could be cut, rents could be lowered, and the general public would benefit by lower prices because merchants' overhead would be reduced.

"For example, the present Chicago code specifies six sacks of cement to a yard of concrete in order to secure a strength of 2,000 pounds. Yet our experience with Wacker Drive showed that with exactly the same materials we can get 3,500 pounds or an increase of 75% in strength without any additional cost." Mr. Lord's paper describing the Wacker Drive project, for which he was consulting engineer on design and construction, won for him the mason medal, awarded by the American Concrete Institute.

Explaining this increased strength of concrete, Mr. Lord said, "We do this by what is called the water-cement ratio which merely means keeping the ratio between the water and cement constant. This discovery, which is not recognized by many city building codes, gives us at the same cost almost twice the strength we need for the work indicated in ordinances. Where this greater strength is not required, by increasing the amount of sand and stone in our concrete mixture, we can obtain the 2,000-pound strength at much lower cost. This is a development and advance in building science which was unknown to us ten years ago when the present ordinance in Chicago was adopted. Bringing our building laws up to date will mean lower building costs and better construction.

"What is true of concrete is true of other materials," Mr. Lord continued. "Take an inch-square bar of steel a yard long which weighs ten pounds. We formerly let it bear an 18,000-pound load. Our tests and experience show that in reality the steel has been loafing on the job for it can easily bear a 20,000-pound load, or an increase of almost 12%. With this more accurate knowledge, greater loads could be applied to both steel and concrete, provided the building ordinances permitted it. This would permit smaller columns and contribute to the architectural beauty and attractiveness of modern buildings."

Building code revision now being considered by the Chicago, New York, and Philadelphia committees would recognize all tested discoveries and advancement made in building knowledge and would provide greater uniformity in the various cities. It is believed that adoption of the new code in the three cities will lead to its adoption in most of the large cities of the country.

Better Than 1927 Edition

J. M. Buchheit, superintendent of the Brixment Mill and Quarries of the Louisville Cement Company, Speed, Indiana, writes of Pit and Quarry Hand Book as follows: "Was very glad to receive 1928 Hand book and would like to say that I have found some very interesting data in this book. I believe that it is really better than the 1927 edition."

FLOTATION OF LOW GRADE PHOSPHATE ORES

By H. M. Lawrence and F. D. DeVaney,
Metallurgist and Jr. Mining Engineer, Bureau of Mines

RECOVERY of phosphate rock from the ores in the land-pebble district of Florida is a simple washing and screening operation. In the washing plants coarse phosphate only is saved. Log-washer overflows and screen-undersize products containing an appreciable content of fine phosphate are discarded. The phosphate grains in the material discharged to waste are generally finer in size than the mesh—14 to 20 mesh or 0.046 to 0.03 inch—of the finest screen in the washer. The operators state that the washers ordinarily recover from 50 to 60 per cent of the phosphate content of the matrix mined. Any increase that can be effected in the recovery of phosphate would be of advantage to the industry and would conserve the mineral resources of the country.

In considering possible methods that might increase the recovery obtained in phosphate-washing plants the application of flotation, if it could be successfully developed, seemed to warrant investigation.

Flotation has been applied, in the laboratory at least, to the beneficiation of Spanish phosphates.[4] An investigation of flotation for Florida phosphates is now under way. In this study the work here reported has been largely confined to screen-undersize products rejected by the washers. Such material is granular and practically free from clay. Also, these undersize products frequently have a phosphate content but little below that of commercial rock and only require the removal of small amounts of quartz gangue to render them marketable.

Types of Ores

Only phosphate ores from the land-pebble district of Florida have so far been studied. The phosphate minerals in these deposits vary in physical and chemical properties. Some of the phosphate grains are hard, well rounded and polished, and black. There are all gradations between pebbles of this type and the soft, white, amorphous variety that is also common. In composition the phosphate minerals are complex, containing lime, magnesia, iron, alumina, fluorine, and organic matter in addition to the lime phosphate. The P_2O_5 content of the different types of phosphate grains varies; in general, it may be said that the P_2O_5 content of the light-colored grains is higher than that of the black grains. From some of the phosphate ores it has not been found possible to obtain a segregate of clean mineral which will contain over 73 to 74 per cent B. P. L. (Bone Phosphate of Lime); these phosphate grains showed no attached quartz particles when viewed under a microscope. From other ores clean picked grains with no visible quartz may contain 78 to 80 per cent B. P. L.

Flotation Tests—Reagents and Results

For flotation testing the ore—minus 10-mesh in size—was ground in an Abbe pebble mill to pass 48 to 65 mesh with 50 to 92 per cent minus 200-mesh. In grinding, the softer phosphate grains were ground finer than the more resistant quartz. Standard procedures for flotation testing were followed. In some cases a clean concentrate and a low tailing were made in a single pass. Ordinarily, however, rougher tests were followed by cleaning runs, and the cleaner tailings were added to the pulp for the succeeding test. The M-S type, hollow-shaft type, and 50-gram laboratory machines were used.

As preliminary work indicated that oleic acid and sodium oleate would give some selective action between the phosphate and quartz reagent combinations have been mainly limited to those containing these two reagents. Results have been obtained in the laboratory machines with several charges; two are listed below.

	First charge Lbs. per ton	Second charge Lbs. per ton
Oleic acid	1.6	...
Sodium oleate	.04	3.0
Heavy crude pine oil	.8	...
Pine oil (steam distilled)	.6	.6
Sodium silicate	.24	1.4
Sodium carbonate	.2	...
Mexican heavy crude petroleum oil	...	.6

In general, in the tests in which the first combination was used the insoluble content of the concentrates was a little lower than when other charges were employed. With the second combination the phosphate content in the tailings tended to be somewhat lower.

In the laboratory tests the cost of the reagents used amounted to 25 to 35 cents per ton of material treated. Frequently, in flotation practice the consumption of reagents is reduced materially from the amounts required in small-scale laboratory tests. There are possibilities for decreasing the reagent consumption if the flotation of phosphates should be applied commercially, particularly if soft water is used.

In the tests so far made distilled water has been used exclusively. It is realized that the water supply in different sections of the country where flotation of phosphates might be practiced will vary in quality. Impurities in the water which tend to make a water hard will consume a certain amount of reagents, more particularly sodium oleate or

(Continued on page 78)

COMPARATIVE TESTS OF CRUSHED STONE AND GRAVEL CONCRETE IN NEW JERSEY

DURING the summer of 1926 the New Jersey State Highway Commission, working in cooperation with the Bureau of Public Roads, conducted a series of concrete tests at the Trenton laboratory of the commission, for the purpose of determining the relative quality and economy of concrete paving mixtures in which 13 different gradations of crushed stone (trap) and

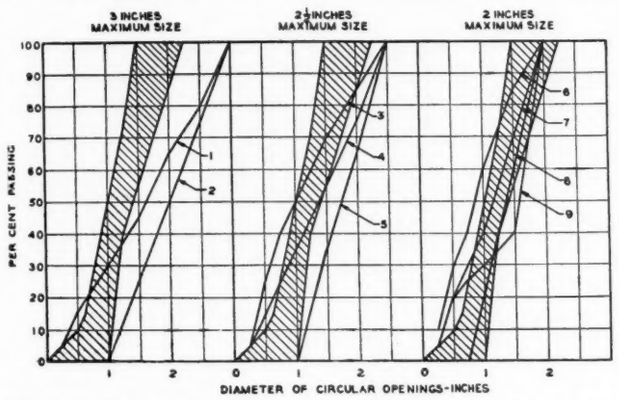


Figure 1—Relation Between Aggregate Grading and State Specifications for Size of Crushed Stone

gravel were used as coarse aggregate. The investigation involved the making and testing of approximately 150 concrete beams, 8 by 8 by 48 inches in size and 250 concrete cylinders 6 by 12 inches in size.

This report describes in order (1) the various reasons which led up to the investigation, (2) the procedure followed, (3) the results secured, and (4) the conclusions reached, and makes certain recommendations relative to the application of these results. It should be borne in mind that this series of tests was initiated for the purpose of studying the relative merits of two different types of coarse aggregate produced under certain conditions. The results can therefore be considered as applicable only to the same kinds of material, produced in a similar manner. In order to make possible the drawing of more general conclusions as to the effect of type and gradation of coarse aggregate upon the quality of concrete a series of tests has been started at the Arlington laboratory of the bureau. These tests are similar to those described here but involve seventeen types of coarse aggregate instead of two. Iit is anticipated that conclusions suitable for general application will be justified by these tests, but in the meantime those presented here should not be considered as having any application beyond particular conditions involved.

Reasons Leading to Investigation

The practice followed in New Jersey and most other States of specifying the same proportions of cement and graded aggregate for concrete, regardless of the void content of these aggregates, has resulted in securing for gravel aggregate in appreciable economic advantage due to the increased yield of concrete obtained from the gravel aggregate on account of its low void content, as well as its lower cost compared with that of crushed stone. These facts, together with the other natural advantages possessed by gravel, such as the increased workability of the resulting concrete, have made its use in general more economical than crushed stone.

Such a condition would not in itself warrant any change in the existing methods of proportioning. It must be remembered, however, that the arbitrary proportions which are set are only a means to an end which, in this case, is the production of concrete possessing certain definite essential physical properties. If a specification is to be considered adequate it must be assumed that, as long as the various details of the specifications relative to materials and construction processes are complied with, concrete of substantially uniform quality will be obtained; in other words, that any variation in either type or gradation of aggregate within the specification limits will not result in any essential change in the quality of the product.

The standard road specifications of the New Jersey Highway Commisiion require that concrete for pavements shall be mixed in the proportions of 1 part cement and 1¾ parts sand and 3½ parts coarse aggregate by volume measured in a loose, dry condition. In the determination of the field mix, the amount of sand is proportioned on a dry, loose basis; that is, a bulking correction is made.

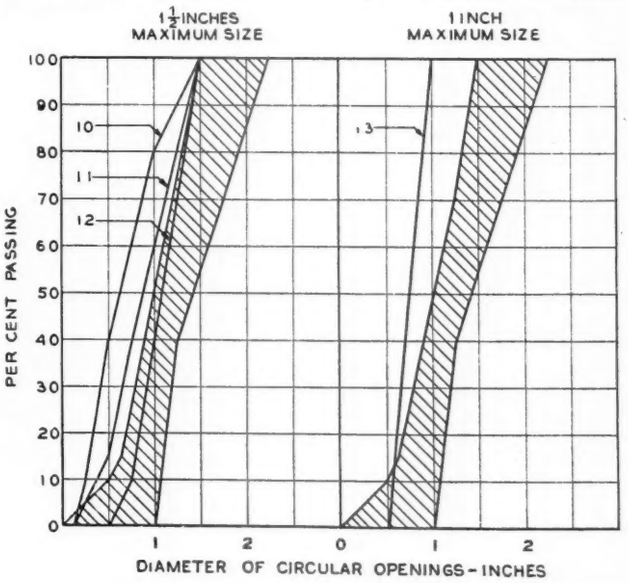


Figure 2—New Jersey State Requirements for Crushed Stone for Concrete Pavements

TABLE 1.—*Gradings of coarse aggregates used in tests*

Coarse aggregate grading No.	Total per cent passing screens with round openings								
	3-in.	2½-in.	2-in.	1½-in.	1-in.	¾-in.	½-in.	¼-in.	⅛-in.
1	100	80	65	45	30	...	15	5	0
2	100	75	50	25	0	...	...	...	...
3	...	100	85	70	50	40	25	5	0
4	...	100	75	55	35	25	15	5	0
5	...	100	65	35	0	...	...	...	...
6	...	...	100	85	60	40	30	10	0
7	...	...	100	70	40	30	20	5	0
8	...	...	100	60	20	0	...	...	...
9	...	...	100	40	30	25	20	5	0
10	...	...	...	100	80	60	40	10	0
11	...	...	...	100	60	40	15	5	0
12	...	...	...	100	40	10	0	...	...
13	...	...	...	...	100	50	0	...	...

Either crushed rock or gravel conforming to certain requirements as to quality and gradation may be used. This, as has been pointed out, results in the production of more concrete per unit volume of cement when gravel is used as coarse aggregate than when stone is used, due of course, to the higher void content of the crushed stone aggregate.

It has been repeatedly urged by the crushed-stone interests in New Jersey that concrete produced from crushed stone is of a better quality than that produced from gravel due to the difference in character of these two aggregates and to the higher cement content of the cement required to produce a unit volume of concrete.

If these claims are true, they are of considerable significance, because it means that, if the gravel concrete produced under the present specifications is satisfactory in quality, the use of crushed stone results in the production of a higher quality of concrete than is demanded by the minimum requirements of the specifications. If, on the other hand, the crushed-stone concrete is no better than it should be, the obvious conclusion is that the gravel concrete will not meet the minimum requirements. In either event, if it is shown that the type of aggregate does affect the quality of the concrete to an appreciable degree, some readjustment should be permitted in order to insure concrete of equal quality irrespective of the type of aggregate used.

TABLE 2.—*Fineness moduli of aggregates used in tests*

Course aggregate grading No.	Maximum size	Fineness modulus	Sand required [1]
	Inches		*Per cent*
1	3	8.0	31
2	3	8.6	39
3	3	7.5	30
4	3	7.9	30
5	3	8.4	37
6	1½	7.2	35
7	2	7.5	30
8	2	8.0	37
9	2	7.6	32
10	1	6.8	39
11	1½	7.3	37
12	1½	7.7	42
13	1	7.2	45
Sand	...	3.2	..

[1] Calculated by fineness-modulus method for a designed strength of 3,500 pounds per square inch, slump of 1 inch and with the sand employed in these tests.

Physical properties of fine aggregate consisting essentially of subangular quartz grains containing some chert and sandstone

Physical Properties—etc			
Sieve analysis:			
Total retained on	¼-inch screen	per cent	7
	No. 10 sieve	do	24
	No. 20 sieve	do	38
	No. 30 sieve	do	62
	No. 50 sieve	do	86
	No. 100 sieve	do	95
Silt and clay		do	1.8
Weight per cubic foot (shaken to refusal)		pounds	108
Tensile strength ratio at 7 days		per cent	123
	28 days	do	120

Scope of Tests and Materials Described

Recognizing the importance of this problem from both the engineering and economic points of view, the Bureau of Public Roads and the New Jersey State Highway Commission undertook a study of the question through a series of carefully controlled laboratory tests to determine the following:

1. The relative strength and yield of crushed-stone and gravel concrete of the same proportions and consistency, and with the same size and grading of coarse aggregate.

2. What grading of coarse aggregate and what proportions of fine to coarse would give the greatest yield for each type of aggregate, when the concrete is designed for a given strength.

In discussing the essential characteristics of paving concrete, it is herein assumed that in so far as strength is concerned, resistance to bending or flexure is of more significance than is resistance to crushing. Many engineers, in designing concrete pavements, employ the flexural strength of the concrete in calculations for edge and center thickness of slabs under given conditions of load and accept it as the criterion of quality rather than the compressive strength. It is obvious, therefore, that factors influencing flexural strength are of critical importance in so far as pavement concrete is concerned.

To secure flexural-strength tests that would not be unduly influenced by the size of the aggregates used, it was decided to make the major strength comparisons from the results secured with concrete beams 8 by 8 by 48 inches in size, tested as

TABLE 3.—*Weight per cubic foot and percentage of voids of coarse aggregates*

Coarse aggregate grading No.	Crushed stone		Gravel	
	Weight per cubic foot	Voids	Weight per cubic foot	Voids
	Pounds	*Per cent*	*Pounds*	*Per cent*
1	110	41	108	34
2	97	48	97	41
3	106	43	107	35
4	103	44	108	34
5	94	49	96	42
6	102	45	106	36
7	103	44	105	36
8	97	48	97	41
9	104	44	107	35
10	97	48	105	36
11	98	47	104	37
12	94	49	98	41
13	90	51	96	42

TABLE 4.—*Water-cement ratio used in series A to produce concrete of uniform consistency*

[Proportions: 1:1¾:3½ by volume. Consistency: Flow equals approximately 140]

Coarse aggregate grading No.	Water-cement ratio for stone concrete	Water-cement ratio for gravel concrete	Coarse aggregate grading No.	Water-cement ratio for stone concrete	Water-cement ratio for gravel concrete
1	0.76	0.76	8	0.71	0.74
2	.69	.70	9	.76	.74
3	.76	.77	10	.83	.78
4	.72	.70	11	.74	.74
5	.68	.66	12	.73	.70
6	.76	.75	13	.79	.74
7	.74	.72			

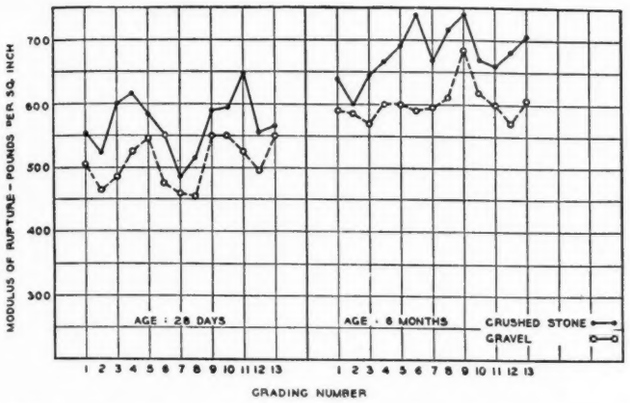


Figure 3—Results of Flexure. Tests of Concrete Specimens of Series A.

cantilever for flexural strength using a device similar to that described by Clemmer in Public Roads for May, 1926. It was also decided to use the ends of the beams from the flexure tests as compression specimens in determining the crushing strength of the concrete as well as the 6 by 12 inch cylinders which were cast for this particular purpose. Tests were to be made on all specimens at the age of 28 days, as well as additional series of tests on the 1:1¾:3½ specimens at the age of six months. Accurate measurements of the yield of concrete obtained from each batch were also to be taken.

Thirteen gradations of crushed trap rock and gravel were employed, ranging from a 3-inch maximum down to a 1-inch maximum size. Well-graded and poorly graded combinations were used, the object being to cover quite a wide range of coarse-aggregate gradations within these limits. The exact screen analysis of each combination is shown in Table 1 and is plotted graphically in Figures 1 and 2, which also show the present New Jersey State requirements for crushed stone for concrete pavements. State requirements for gravel for concrete are similar to those for crushed stone except that more material finer than one-half inch is permitted in the gravel than the crushed stone. For convenience in visualizing the gradings of the coarse aggregate, the fineness modulus of each combination was calculated and is shown in Table 2, together with the "Maximum size," a value to be used in connection with any design calculations which might be made by the fineness-modulus method. This table also shows the percentage of fine aggregate required by the fineness-modulus method for each gradation calculated on the basis of the sand employed in these tests.

The crushed stone was obtained from Bound Brook, N. J., and the gravel from Morrisville, Pa. The rock is representative of the extensive deposits of basalt (trap rock) quarried in northern New Jersey. This material is very hard and tough, showing a percentage of wear of 2.2 (French coefficient equals 18.2), apparent specific gravity of 2.97 (weight per cubic foot, solid, 185 pounds), and a water absorption of 0.5 per cent. The gravel is representative of material of the type used extensively throughout this region. It consists essentially of rounded fragments of sandstone, flint, and quartz, has an apparent specific gravity of 2.65 (weight per cubic foot solid, of 165 pounds) and a water absorption of 9.68 per cent.

TABLE 5.—*Flexural strength of concrete specimens of series A mixed in the proportions 1:1¾:3½ by volume (nominal mix) and with a flow of approximately 140*[1]

Coarse aggregate grading No.	Modulus of rupture, 28-day tests						Modulus of rupture, 6-month tests					
	Stone			Gravel			Stone			Gravel		
	Round No. 1	Round No. 2	Average	Round No. 1	Round No. 2	Average	Round No. 1	Round No. 2	Average	Round No. 1	Round No. 2	Average
	Lbs. per sq. in.	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*
1	545	565	555	475	530	500	610	670	640	590	585	590
2	535	515	525	470	455	460	610	590	600	575	590	580
3	620	575	600	455	510	480	630	655	640	580	560	570
4	600	630	615	520	530	525	680	650	665	605	600	600
5	540	625	580	530	555	540	675	705	690	610	590	600
6	550	555	550	455	490	470	705	770	740	625	555	590
7	505	465	485	435	480	460	680	655	670	635	555	595
8	515	515	515	435	475	455	770	660	715	655	560	610
9	550	630	590	490	605	550	700	780	740	695	675	685
10	575	610	590	540	555	550	605	735	670	595	640	620
11	690	610	650	560	490	525	670	645	660	645	550	600
12	525	585	555	520	465	490	675	685	680	580	555	570
13	555	575	565	565	535	550	690	720	705	630	580	605
Average			570			505			680			600
Maximum			650			550			740			685
Minimum			485			455			600			570

[1]Determinations made on concrete beams 8 by 8 by 48 inches in size, tested as cantilevers. Each value is the average of two breaks on one beam.

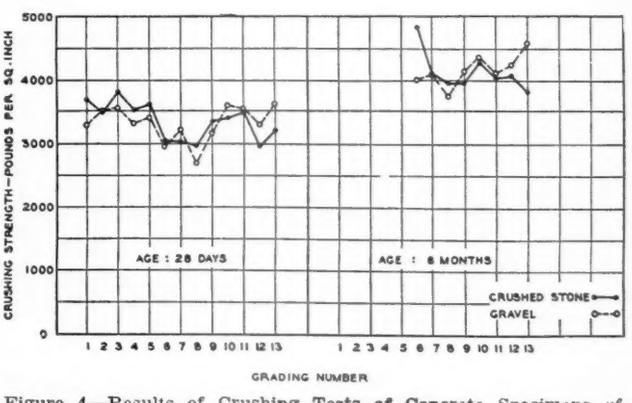


Figure 4—Results of Crushing Tests of Concrete Specimens of Series A.

TABLE 6.—*Compressive strength of concrete specimens of series A mixed in the proportions 1:1¾:3½ by volume (nominal mix) and with a flow of approximately 140*[1]

Coarse aggregate grading No.	Crushing strength, 28-day tests						Crushing strength, 6-month tests					
	Stone			Gravel			Stone			Gravel		
	Round No. 1	Round No. 2	Average	Round No. 1	Round No. 2	Average	Round No. 1	Round No. 2	Average	Round No. 1	Round No. 2	Average
	Lbs. per sq. in.	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*
1	4,255	3,160	3,710	3,580	3,020	3,300	None made.					
2	3,955	3,050	3,500	3,600	3,455	3,530						
3	4,300	3,385	3,840	3,595	3,565	3,580						
4	3,630	3,470	3,550	3,255	3,440	3,350						
5	3,510	3,760	3,635	3,475	3,370	3,420						
6	3,285	2,860	3,070	3,070	2,890	2,980	4,630	5,085	4,860	3,345	4,700	4,020
7	3,145	2,920	3,030	3,115	3,360	3,240	4,050	4,205	4,130	4,090	4,145	4,120
8	3,230	2,720	2,975	2,740	2,685	2,710	4,535	3,405	3,970	4,420	3,110	3,765
9	3,215	3,505	3,360	2,860	3,510	3,185	3,880	4,090	3,985	3,740	4,570	4,155
10	3,830	3,020	3,425	3,620	3,600	3,610	4,695	3,945	4,320	4,220	4,525	4,370
11	3,715	3,285	3,500	3,635	3,490	3,560	4,780	3,295	4,040	4,610	3,655	4,130
12	3,530	2,410	2,970	3,540	3,070	3,305	4,420	3,725	4,070	4,205	4,305	4,255
13	3,540	2,890	3,215	3,600	3,725	3,660	4,030	3,595	3,810	4,495	4,695	4,595
Average			3,370			3,340			4,150			4,180
Maximum			3,840			3,660			4,860			4,595
Minimum			2,970			2,710			3,810			3,765

[1]For coarse aggregate gradings Nos. 1 to 5, inclusive, crushing-strength tests were made on portions of beams from flexure tests; each value is the average of two tests. For coarse aggregate gradings Nos. 6 to 13, inclusive, crushing-strength tests were made on 6 by 12 inch cylinders; each value is the average of three tests.

The fine aggregate used in the tests was also obtained at Morrisville, Pennsylvania, and meets all the conventional tests for first-grade concrete sand. The physical properties of the sand are shown below. Its apparent specific gravity was 2.65 (weight per cubic foot, solid, 165 pounds and its weight per cubic foot, dry, and shaken to refusal, 108 pounds).

The cement was a standard Portland, passing all physical test requirements. It was a brand used extensively in New Jersey.

The percentage of voids for each aggregate in each of the 13 grading combinations as calculated from the apparent specific gravities and the unit weights are shown in Table 3. These values were used in all calculations of volume-weight relations.

Test Procedure for Series A

In series A the concrete was proportioned by volume, using a nominal mix of 1:1¾:3½. As far as could be measured by the use of the flow table, a constant consistency was maintained throughout the series, the quantity of water being varied as necessary. The flow test was made on the 30-inch flow table, using 30 drops from a height of one-half inch. In this report the flow is expressed as the final diameter in tenths of inches of a truncated cone of concrete, which had on original diameter at the base of 10 inches. For example, a flow of 140 indicates a final diameter of the base of 14 inches. The consistency employed, which was as nearly as possible that required in actual construction, gave a flow of 140 corresponding to a slump of from 1 inch to 2 inches. It was found necessary to vary the water-cement ratio from 0.67 to 0.83 in order to maintain a constant consistency throughout the range of coarse-aggregate gradings. The water-cement ratios used in series A are given in Table 4. No correction for water absorbed by the aggregate was made in calculating these values.

The actual quantities of materials required for each batch of concrete were determined by weight, using the volume-weight relations given in Table

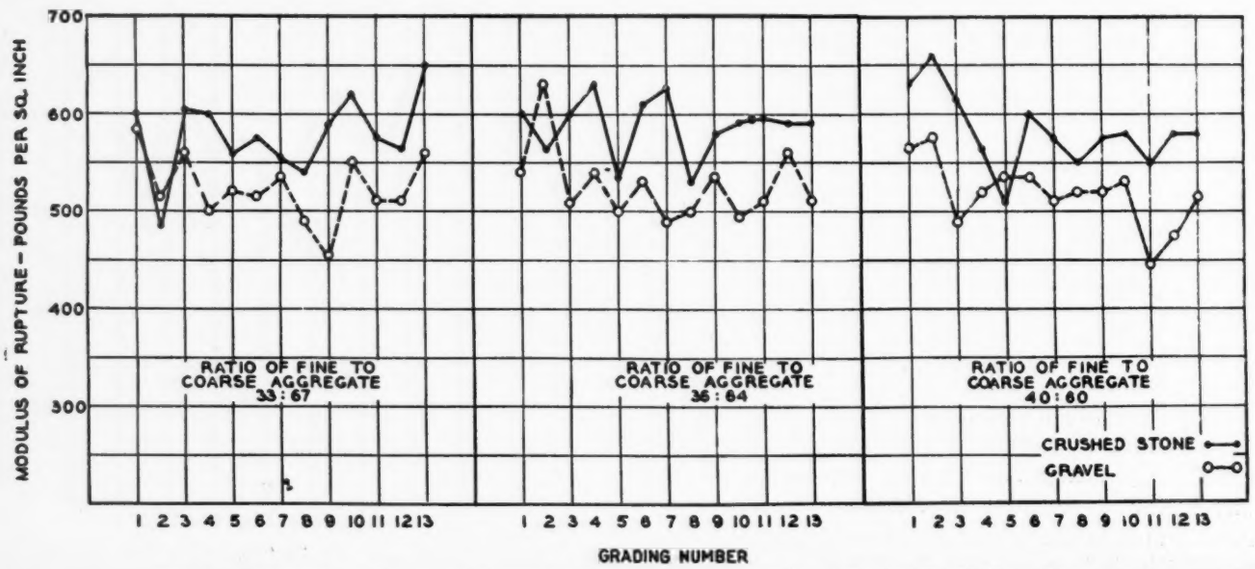

MODULUS OF RUPTURE – POUNDS PER SQ. INCH
700
600
500
400
300
RATIO OF FINE TO COARSE AGGREGATE 33:67
RATIO OF FINE TO COARSE AGGREGATE 36:64
RATIO OF FINE TO COARSE AGGREGATE 40:60
CRUSHED STONE
GRAVEL
1 2 3 4 5 6 7 8 9 10 11 12 13
GRADING NUMBER

FIG. 5.—RESULTS OF FLEXURE TESTS OF CONCRETE SPECIMENS OF SERIES B, 28-DAY TESTS

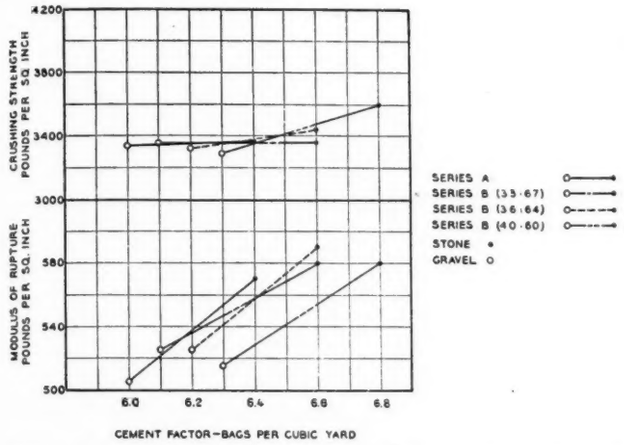


Figure 6—Relation Between Strength of Concrete and Cement Factor. General Average for All Grades.

3. A sufficient quantity of each size of aggregate was weighed for each batch, so as to secure the required total volume. In this way, all tendency toward segregation was avoided. In order to properly gauge the quantity of water required for each test batch, a trial batch of the same proportions was mixed by hand and the proper amount of water determined by trial. This procedure, while adding considerably to the labor involved, resulted in test batches of much greater uniformity in consistency than would otherwise have been possible.

The actual test batches were mixed in a 1-bag gasoline-driven mixer. For the gradings number 1 to 5, inclusive, the quantities of materials used in each batch were based on a coarse aggregate volume of 1.8 cubic feet, producing a slight excess of concrete over that required for one beam. For the gradings numbered 6 to 13, inclusive, quantities were based on a coarse-aggregate volume of 2.4 cubic feet, producing sufficient concrete for one beam and three cylinders. All batches were mixed for two minutes after all ingredients had been added. After mixing, the batch was dumped upon a water-tight platform, flow tests for consistency made, and specimens cast. Concrete was rodded into molds in accordance with approved methods of molding. Accurate determinations of yield were made by determining both the volume and the weight of the concrete remaining after the specimens had been cast.

Specimens were cured for 24 hours under damp cloths in the laboratory, after which the forms were removed and the specimens placed in a moist room until tested. Tests were made at 28 days and at 6 months.

To eliminate the effect of other variables on the relative strength of the crushed-stone and gravel concrete, specimens employing crushed stone and gravel of the same gradation were always cast in pairs. The entire series of gradations was also

TABLE 7.—*Proportions used in series B to obtain flow of 140 with water-cement ratio of 0.72*

Coarse aggregate grading No.	Ratio sand to coarse aggregate 33:67		Ratio sand to coarse aggregate 36:64		Ratio sand to coarse aggregate 40:60	
	Stone	Gravel	Stone	Gravel	Stone	Gravel
1	1:1.68:3.37	1:1.72:3.44	1:1.72:3.06	1:1.81:3.22	1:1.78:2.67	1:1.85:2.78
2	1:1.96:3.92	1:1.98:3.96	1:1.96:3.49	1:2.01:3.58	1:2.05:3.07	1:2.14:3.21
3	1:1.62:3.24	1:1.68:3.36	1:1.70:3.03	1:1.82:3.24	1:1.86:2.79	1:1.92:2.88
4	1:1.79:3.58	1:1.63:3.27	1:1.84:3.28	1:1.85:3.29	1:1.93:2.90	1:1.99:2.99
5	1:1.88:3.75	1:1.90:3.80	1:1.97:3.51	1:1.99:3.55	1:1.92:2.88	1:2.18:3.28
6	1:1.52:3.04	1:1.55:3.11	1:1.63:2.90	1:1.66:2.95	1:1.84:2.76	1:1.88:2.82
7	1:1.57:3.14	1:1.70:3.39	1:1.80:3.20	1:1.73:3.08	1:1.82:2.73	1:1.88:2.82
8	1:1.84:3.68	1:1.87:3.75	1:1.93:3.44	1:1.95:3.47	1:2.02:3.03	1:2.01:3.02
9	1:1.67:3.34	1:1.71:3.42	1:1.90:3.38	1:1.81:3.22	1:1.78:2.68	1:1.89:2.83
10	1:1.47:2.94	1:1.47:2.94	1:1.53:2.72	1:1.52:2.71	1:1.67:2.50	1:1.78:2.68
11	1:1.59:3.18	1:1.62:3.24	1:1.70:3.03	1:1.72:3.06	1:1.91:2.87	1:1.83:2.74
12	1:1.72:3.44	1:1.82:3.64	1:1.90:3.38	1:1.80:3.20	1:2.06:3.09	1:2.03:3.05
13	1:1.62:3.24	1:1.67:3.35	1:1.74:3.10	1:1.71:3.05	1:1.91:2.86	1:1.93:2.90

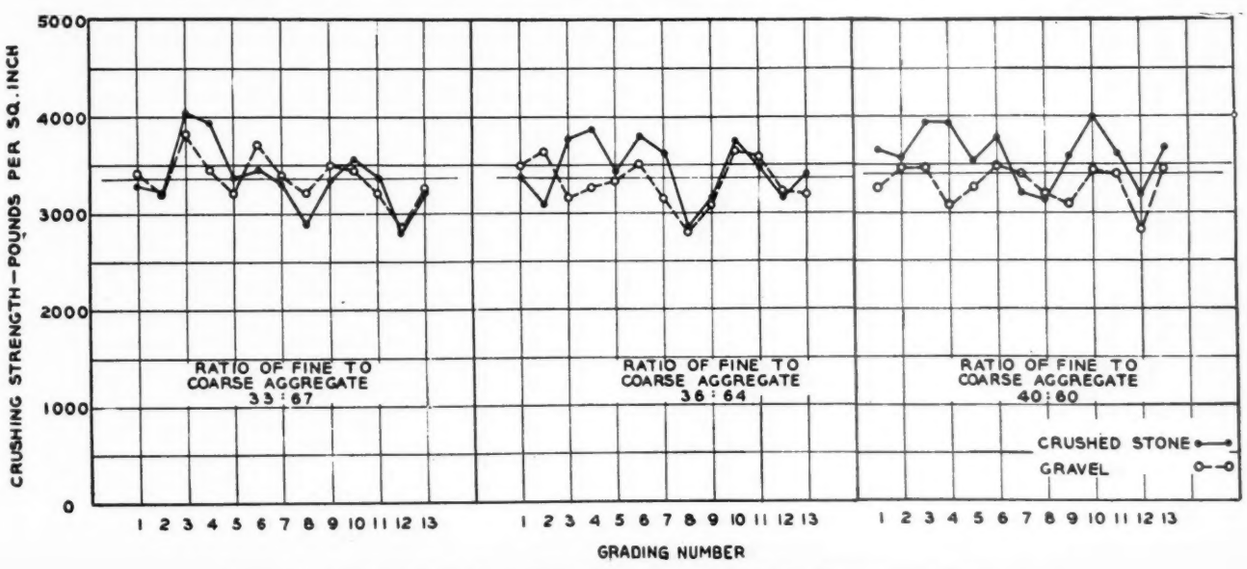


Figure 7—Crushing Strength of Concrete Specimens of Series B at Age of 28 Days

TABLE 8.—*Flexural strength of concrete specimens of series B, 28-day tests*[1]

Coarse aggregate grading No.	Ratio sand to coarse aggregate 33:67						Ratio sand to coarse aggregate 36:64						Ratio sand to coarse aggregate 40:60					
	Stone			Gravel			Stone			Gravel			Stone			Gravel		
	Round No. 1	Round No. 2	Average	Round No. 1	Round No. 2	Average	Round No. 1	Round No. 2	Average	Round No. 1	Round No. 2	Average	Round No. 1	Round No. 2	Average	Round No. 1	Round No. 2	Average
	Lbs. per sq in.	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*
1	660	540	600	640	530	585	615	585	600	525	555	540	690	565	630	575	550	560
2	520	450	485	515	515	515	565	560	560	570	685	630	720	595	660	625	520	570
3	570	640	605	575	540	560	560	635	600	510	505	510	585	645	615	475	505	490
4	580	620	600	505	500	500	605	655	630	525	550	540	555	570	560	525	510	520
5	590	525	560	505	530	520	560	505	530	480	525	500	495	525	510	545	520	530
6	590	555	570	530	500	515	580	640	610	500	560	530	600	605	600	530	535	530
7	565	545	555	555	510	530	665	590	630	515	465	490	565	585	575	470	550	510
8	525	550	540	490	485	490	585	475	530	525	480	500	550	545	550	490	545	520
9	575	605	590	510	400	455	600	555	580	540	525	530	575	575	575	545	490	520
10	600	645	620	505	590	550	600	580	590	510	475	490	580	575	580	540	520	530
11	595	555	575	515	500	510	600	590	595	480	535	510	575	530	550	420	465	440
12	560	570	565	515	500	510	575	600	590	545	570	560	620	535	580	490	455	470
13	665	630	650	530	585	560	595	585	590	510	510	510	595	565	580	495	535	515
Average			580			525	...	...	590	...	...	525	...	...	580	...	...	515
Maximum			650			585	...	...	630	...	...	630	...	...	660	...	...	570
Minimum			485			455	...	...	530	...	...	490	...	...	510	...	...	440

[1]Determinations made on concrete beams 8 by 8 by 48 inches in size. Each value is the average of two breaks on one beam.

completed before being repeated, several days usually elapsing between the first and second rounds. Variations in temperature and humidity conditions throughout the test were compensated for in this way, making possible a more satisfactory comparison of the effect of aggregate grading on strength.

In testing the beams for flexural strength, two breaks were made on each specimen and the results averaged and reported, after calculation, as the modulus of rupture for the round. (See Table 5.) The corresponding values for round 2 were obtained in the same way. The average of the two rounds was reported as the average value for the type of aggregate, the grading, and the age involved. Each average value for modulus of rupture represents four breaks on two specimens tested on different days.

Average compression test values, as given in Table 6, were obtained in the same manner, except those for gradings Nos. 6 to 13, inclusive, each value for each round is the average of tests on three cylinders.

Test Procedure for Series B

In series B an entirely different method of proportioning was employed, but the various details of mixing, molding, curing, and testing were exactly the same as in series A. In this series the concrete was designed according to the so-called trial method application of the water-cement ratio theory which is being advocated by the Portland Cement Association and which is described in a bulletin published by the association. The design called for a crushing strength at 28 days of 3,500 pounds, using a water-cement ratio of 0.72. The object was to secure data showing how variations in the type and gradation of coarse aggregate and the strength and yield when proportioned by the trial method.

To secure a uniform consistency as used in series A, but with a constant water-cement ratio, the procedure in determining the proper porportions was as follows:

A paste of water and cement in the ratio required (0.72) was prepared and added to a mixture of fine and coarse aggregate until a consistency was obtained approximating a flow of 140. Three mixtures of fine and coarse aggregate were used. They were proportioned by volume in the following ratios, 33:67, 36:64, and 40:60. Trials were made with small hand-mixed batches for each type and grading of coarse aggregate, using each of the ratios of fine to coarse aggregate, and the proportoins for the test batches were calculated from the resulting weights. The calculated proportions in series B for all combinations were given in Table 7. This work was done in strict accordance with the procedure recommended by the Portland Cement Association for the design of concrete mixtures.

There were slight differences in consistency between the machine-mixed batches and the small trial batches, even when gauged with the same amount of water, and some preliminary experimental work was necessary to establish the relation between the two. After a little experience it was found possible to proportion the trial batches for a water-cement ratio of 0.72, so that the consistency of the large test batches after two

TABLE 9.—*Comparison of average results of 28-day tests of series A and series B*

Series	Coarse aggregate	Ratio fine to coarse aggregate	Average modulus of rupture	Average crushing strength	Average cement factor
			Lbs. per sq. in.	*Lbs. per sq. in.*	*Bags per cu. yd.*
A	Stone	33:67	570	3.370	6.4
	Gravel	33.67	505	3.340	6.0
B	Stone	33:67	580	3.360	6.6
	Gravel	33:67	525	3.360	6.1
B	Stone	36:64	590	3.440	6.6
	Gravel	36:64	525	3.310	6.2
B	Stone	40:60	580	3.600	6.8
	Gravel	40:60	515	3.290	6.3

NOTE.—Each value for flexural strength is the average of 52 tests. Each value for crushing strength is the average of 68 tests.
In series A the proportions were 1:1¾:3½ by volume; flow, 140; water-cement ratio varied from 0.67 to 0.81.
In series B the proportions were determined by trial (Portland Cement Association method to give a flow of 140, with a water-cement ratio of 0.72).

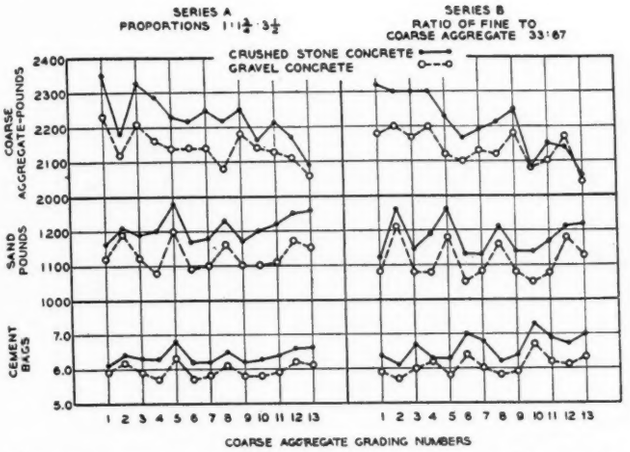


Figure 8—Quantities of Material Required for 1 Cubic Yard of Concrete

minutes mixing would not vary more than ±5 points from a flow of 140. Any batches showing a greater deviation were discarded.

The necessity of maintaining a uniform consistency was recognized. It is realized, of course, that there is an intimate relation between consistency, water-cement ratio, and proportions for different gradations of aggregate. If any two of these factors are kept constant, it is necessary to vary the other whenever the aggregate grading varies. In this case only the coarse aggregate varied and the sand remained constant. In series A the proportions and consistency were kept constant and the water-cement ratio varied, while in series B the consistency and water-cement ratio were kept constant and the proportions varied. The latter is, of course, the rational method if we assume that strength is proportional to water-cement ratio within the range of workable mixtures.

Strength Data Obtained in Series

As previously stated, the tests included in series A were made to obtain some definite information as to the relative strength and yield of crushed-stone and gravel concrete when proportioned in accordance with current New Jersey specifications and with the various coarse-aggregate gradings indicated.

The results of the flexure tests at both 28 days and 6 months are given in Table 5 and are plotted in Figure 3. An examination of this table indicates that the crushed-stone concrete is considerably higher in textural strength than the gravel concrete. The average increase for all 13 gradations is seen to be 65 pounds per square inch at 28 days, and 80 pounds per square inch at 6 months; approximately 13 per cent in both cases. The concordance of the results is quite remarkable in view of the rather limited number of test specimens involved. Out of a total of 52 pairs of test specimens in the group, the crushed-stone concrete shows higher flexural strength in 49 cases; the values are the same in one case and the gravel concrete shows higher values in two cases. An inspection of the averages of the two rounds shows the crushed-stone concrete higher in all cases, as is indicated graphically in Figure 3. The results given in Table 6 and plotted in Figure 4, however, indicate that this difference is not reflected in the crushing strength of the concrete, the crushed-stone concrete in this case averaging practically the same as the gravel concrete at each period. These tables and figures do not reveal any consistent relation between either maximum size or gradation of coarse aggregate and the strength, either flexural or crushing. This is not particularly surprising in view of the small number of specimens of each gradation represented. This would seem to indicate that possibly variations in grading do not have a very marked effect upon strength, at least in so far as concrete of this particular proportion (1:1¾:1½) is concerned. It is true that a number of the mixes were undersanded when judged by the standard set-up by the fineness-modulus method of proportioning. Gradings Nos. 2, 5, 8, 10, 11, 12 and 13 when proportioned by this method would require a sand-coarse aggregate ratio of approximately 2:3 instead of 1:2 as given by the 1:1¾:3½ mix.

In the case of the smaller aggregates, as for instance gradings Nos. 10 to 13, inclusive, it is probable that this additional sand would have necessitated sufficient additional water for the same consistency to cause an appreciable lowering of the strength. Variations in the water-cement ratio required because of variations in coarse-aggregate grading with a fixed quantity of sand, as used in this series (Table 4) do not appear to be sufficient to affect the strength consistently. This fact is of considerable practical significance because it indicates that changes in the water content made necessary on the job to maintain a given consistency when variations in coarse-aggregate grading occur do not affect the strength as much as is sometimes supposed. There is, however, a very

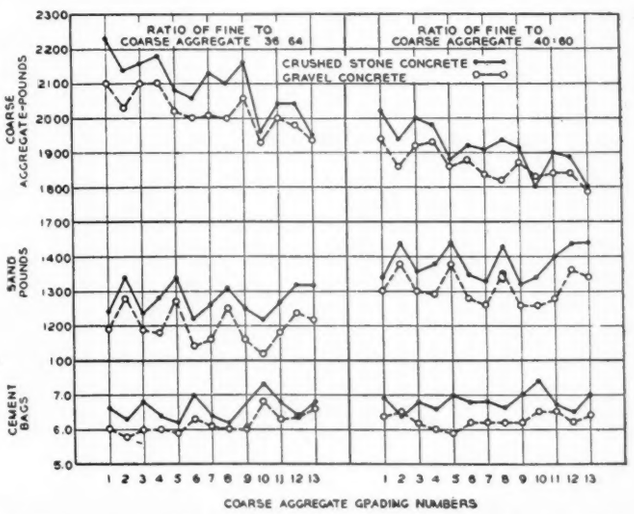


Figure 9—Quantities of Materials Required for 1 Cubic Yard of Concrete

TABLE 10.—*Deviations in per cent of individual values for flexural strength from the mean of each group and for each material, based on 28-day tests*[1]

Coarse aggregate grading No.	Series A		Series B					
			Ratio fine to coarse aggregate, 33:67		Ratio fine to coarse aggregate, 36:64		Ratio fine to coarse aggregate, 40:60	
	Stone	Gravel	Stone	Gravel	Stone	Gravel	Stone	Gravel
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
1	−3	−1	+3	+11	+2	+3	+9	+9
2	−8	−9	−16	−2	−5	+20	+14	+11
3	+5	−5	+4	+7	+2	−3	+6	−5
4	+8	+4	+3	−5	+7	+3	−3	+1
5	+2	+7	−3	−1	−10	−5	−12	+3
6	−4	−7	−2	−2	+3	+1	+3	+3
7	−15	−9	−4	+1	+7	−7	−1	−1
8	−10	−10	−7	−7	−10	−5	−5	+1
9	+4	+9	+2	−13	−2	+1	−1	+1
10	+4	+9	+7	+5	0	−7	0	+3
11	+14	+4	−1	−3	+1	−3	−5	−15
12	−3	−3	−3	−3	0	+7	0	−9
13	−1	+9	+12	+7	0	−3	0	0
Aver. deviation	6	7	5	5	4	5	5	5

[1] Total number of values, 104. Number in which deviation exceeds 10 per cent, 11; number in which deviation exceeds 5 per cent, 38; number in which deviation is 5 per cent or less, 66.

appreciable effect on yield, and therefore on relative economy, which will be discussed later.

Strength Data Obtained in Series B

The data secured as the result of tests of series B are interesting because we have not only an opportunity to study variation in strength for a fixed water-cement ratio, but we can also study the effect of variation in the ratio of sand to coarse aggregate on the strength and yield. It will be remembered that in this series the concrete was proportioned by trial so as to give a consistency of 140 by the flow test for a water-cement ratio of 0.72 and that three sand-coarse-aggregate ratios were employed, 33:67, 36:64 and 40:60. The actual proportions which were derived are given in Table 7, and vary all the way from a 1:1.67:2.50 mix for grading No. 10, stone (40:60 ratio), to a 1:1.98:3.96 mix for grading No. 2, gravel (33:67 ration). The resulting yield and therefore economy of these mixes will be discussed later. These mixes were all designed to give a crushing strength at 28 days of 3,500 pounds per square inch.

The results of the flexural strength test for each of the three aggregate ratios are shown in Table 7 and are plotted in Figure 5. Inspecting general averages, not only were almost identical values for moduli of rupture at 28 days found as were found for series A, but what is somewhat more significant, the same relative increase in strength for the crushed-stone concrete as compared with the gravel concrete was found. These average values are grouped together for comparison in Table 9 and Figure 6. The percentage of increase is, however, not quite so great, ranging from 10 per cent for the 33:67 mix to 13 per cent for the 40:60 combination.

The figures demonstrate the danger of designing concrete for resistance to flexure solely on the basis of water-cement ratio without regard to the type of aggregate employed.

Reverting again to Figure 5 and discussing the detail values for flexural strength in series B, it is seen that the graphs show considerable variation in strength. Attention should be called, however, to the fact that the vertical scale to which these values have been plotted is very large and that in reality the deviations from the group averages are in general quite small.

Table 10 shows the deviations in percentage of the individual values for each grading and type of aggregate from the group average. It will be seen that the average deviations for the three groups in series B are essentially the same and are slightly less than those in series A. It is interesting to note also that in six cases out of eight, grading No. 2 shows a deviation in excess of 5 per cent. This was a poorly graded material with a maximum size of 3 inches. The most significant detail as regards these figures, however, is the fact that for all intents and purposes the flexural strengths obtained in series B for each type of aggregate are practically uniform, the deviation being no more than must be expected even in carefully conducted laboratory work.

TABLE 11.—*Results of crushing strength tests of specimens of series B at age of 28 days*[1]

Coarse aggregate grading No.	Crushed Stone			Gravel		
	Round No. 1	Round No. 2	Average	Round No. 1	Round No. 2	Average
	Lbs. per sq. in.	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*
RATIO OF FINE TO COARSE AGGREGATE 33:67						
1	3,370	3,215	3,290	3,230	3,595	3,410
2	3,370	3,040	3,205	3,220	3,185	3,200
3	4,230	3,860	4,045	3,785	3,855	3,820
4	3,825	4,065	3,945	3,690	3,240	3,465
5	3,590	3,150	3,370	3,820	2,605	3,210
6	3,710	3,205	3,460	3,345	4,075	3,710
7	3,455	3,145	3,300	3,375	3,410	3,390
8	2,950	2,645	2,800	3,200	3,210	3,205
9	3,695	2,985	3,340	3,365	3,720	3,540
10	4,025	3,090	3,560	3,490	3,405	3,450
11	3,710	3,000	3,355	3,635	2,580	3,210
12	3,025	2,580	2,800	3,120	2,535	2,830
13	3,465	2,945	3,205	3,205	3,315	3,260
Average	....	....	3,360	....	....	3,360
Maximum	....	....	4,045	....	....	3,820
Minimum	....	....	2,800	....	....	2,830
RATIO OF FINE TO COARSE AGGREGATE 36:64						
1	3,520	3,245	3,380	3,605	3,385	3,495
2	3,090	3,075	3,080	3,245	4,015	3,630
3	3,975	3,560	3,770	3,165	3,160	3,160
4	3,645	4,060	3,850	3,190	3,325	3,260
5	3,455	3,375	3,415	2,075	3,685	3,330
6	3,790	3,805	3,800	3,190	3,815	3,500
7	3,285	3,925	3,605	3,085	3,215	3,150
8	2,845	2,895	2,870	2,885	2,725	2,805
9	3,125	3,190	3,160	3,170	3,000	3,085
10	3,550	3,950	3,750	3,640	3,680	3,660
11	3,175	3,785	3,480	3,225	3,935	3,580
12	3,025	3,310	3,170	3,440	2,990	3,215
13	3,225	3,580	3,400	2,870	3,515	3,190
Average	....	....	3,440	....	....	3,310
Maximum	....	....	3,850	....	....	3,600
Minimum	....	....	2,870	....	....	2,805
RATIO OF FINE TO COARSE AGGREGATE 40:60						
1	3,970	3,360	3,665	3,040	3,460	3,250
2	3,335	3,805	3,570	3,490	3,425	3,460
3	3,765	4,065	3,915	3,045	3,890	3,470
4	3,670	4,190	3,930	3,240	2,895	3,070
5	3,500	3,590	3,545	3,365	3,150	3,260
6	4,165	3,385	3,775	3,490	3,460	3,475
7	3,540	2,865	3,200	3,180	3,630	3,405
8	3,200	3,060	3,130	3,285	3,115	3,200
9	3,720	3,475	3,600	3,190	2,970	3,080
10	4,055	3,920	3,990	3,610	3,260	3,435
11	3,610	3,600	3,605	3,480	3,285	3,380
12	3,145	3,235	3,190	3,020	2,625	2,820
13	3,435	3,905	3,670	3,540	3,365	3,450
Average	....	....	3,600	....	....	3,290
Maximum	....	....	3,990	....	....	3,475
Minimum	....	....	3,130	....	....	2,820

[1] For coarse-aggregate gradings 1 to 5, inclusive, crushing-strength tests were made on portion of beams from flexure tests. Each value is the average of two breaks. For coarse-aggregate gradings 6 to 13, inclusive, crushing-strength tests were made on 6 by 12 inch cylinders. Each value is average of three tests.

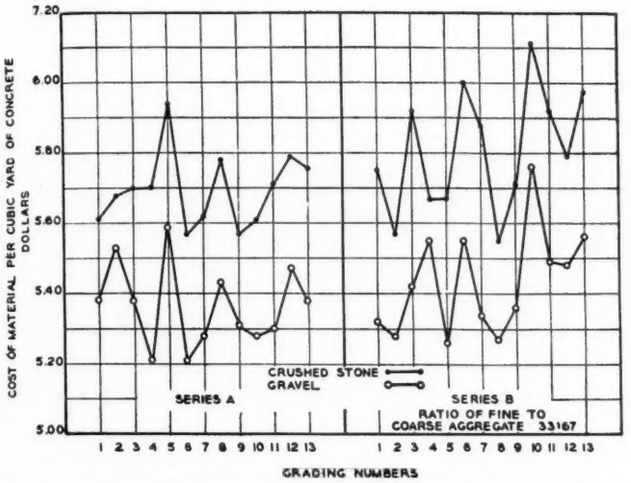


Figure 10—Relation Between Grading of Coarse Aggregate and Total Cost of Material to Produce 1 Cubic Yard of Concrete

The results of crushing strength tests on specimens of series B are shown in Table 11 and are plotted in Figure 7. The group averages are summarized in Table 9. As in the case of the flexure tests, the deviation from the averages are, in general, neither consistent nor of great magnitude. Either of the three aggregate ratios seem to produce concrete of about the same strength regardless of grading, which again seems to indicate that so far as strength alone is concerned grading of coarse aggregate within the limits here indicated is not an important factor. The words "strength alone" are used here and elsewhere advisedly.

Aside from the yield or relative economy of the different gradations, which is a subject entirely apart from the question of quality, variations in grading which produce harsh concrete difficult to handle and place, will unquestionably affect the strength on the job, because of the invariable tendency of the concrete gang to use excess water with such a mix. In these tests an effort was made to secure comparable workability of the different batches by means of the flow test. The slump test was, of course, entirely unsuited to this kind of work. The flow test was used because there was nothing better. It is, however, not a test for workability in the strict sense of the word, so that several of the undersanded mixtures with the ratio of fine to coarse aggregate of 33:67 were probably unworkable in the sense that they would have been difficult to place and finish on the job. The point that it is intended to emphasize is, that it was possible to control the water-cement ratio in the laboratory but it would not be at all easy in actual construction unless the control was very rigid.

Absorption Tests Made

A short series of absorption tests were made on the concrete of series A at age of six months. The results are given in Table 12 and indicate that there is practically no difference between the absorption of the stone and the gravel concrete. These tests were made by immersing samples of concrete from the broken beams in water for 24 hours and noting the increase in weight.

Yield of Concrete Discussed

A study of the relative economy of various concrete mixtures, all of which may have the same strength, is just beginning to occupy the attention of engineers and progressive contractors. It was formerly assumed and is still stated in many handbooks that, for a given proportion of cement, sand, and coarse aggregate, definite amounts of materials are required to produce a cubic yard of concrete. While the values given may be correct as average values it is known that there are many factors which may appreciably alter any one or more of these quantities under certain conditions. In this report the writer is concerned primarily with the effect of type and gradation of coarse aggregate on yield.

Series A

Table 13 gives the computed quantities of material required for 1 cubic yard of concrete for each type and gradation of aggregate used in these tests, while Table 14 gives the corresponding solid volumes of the materials and the density of the concrete (total solids expressed as a percentage of 27 cubic feet). Quantities of materials are plotted in Figures 8 and 9. These figures illustrate graphically the fluctuations in the quantities of materials required to produce 1 cubic yard of concrete due to variations in the grading of the coarse aggregate. Assuming unit costs for cement, sand, and coarse aggregate, these values may be used to determine the cost of the materials in a cubic yard of concrete for each grading and aggregate type shown. Allowance should be made for the fact that the figures for any particular case may be somewhat out of line because of inaccuracies which result from experimental errors. For this reason, comparisons of the effect of aggregate type on yield should only be made on averages for all gradations, as in this way the number of specimens tend to

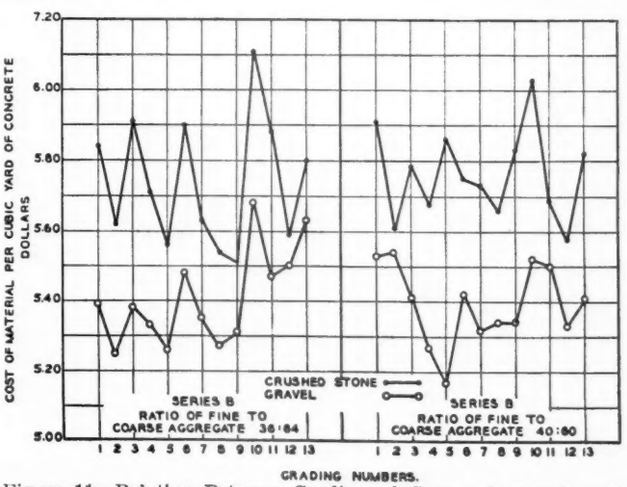


Figure 11—Relation Between Grading of Coarse Aggregate and Total Cost of Material to Produce 1 Cubic Yard of Concrete.

TABLE 12.—*Absorption tests on concrete of series A at age of six months*

Coarse aggregate grading No.	Water absorbed by stone concrete			Water absorbed by gravel concrete		
	Specimen No. 1	Specimen No. 2	Average	Specimen No. 1	Specimen No. 2	Average
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1	5.5	5.0	5.3	4.8	5.9	5.4
2	5.8	4.8	5.3	4.8	5.2	5.0
3	5.9	5.6	5.8	5.6	5.5	5.6
4	4.3	5.1	4.7	4.5	5.0	4.8
5	4.3	5.6	5.0	4.9	5.0	5.0
6	5.6	5.6	5.6	5.6	5.8	5.7
7	5.6	5.6	5.6	5.1	4.9	5.0
8	5.0	6.3	5.7	5.0	5.4	5.2
9	6.0	5.8	5.9	4.8	5.2	5.0
10	6.2	5.8	6.0	5.1	6.0	5.6
11	5.2	5.7	5.5	4.8	5.9	5.4
12	4.9	5.0	5.0	5.2	5.8	5.5
13	5.4	5.8	5.6	5.6	5.5	5.6
Average	..	..	5.5	..	..	5.3

largely eliminate the effect of experimental errors. The results for the individual gradings, however, are of interest to the extent that they indicate general relationships. For example, Figures 8 and 9 show at a glance the effect of gradings 2, 5, 8, 12 and 13 on the various quantities required to produce a cubic yard of concrete. The amount of cement and sand required is larger and the amount of coarse aggregate required is smaller than where the coarse aggregate contains the smaller sizes.

To bring out certain possible cost relations and illustrate the economic features involved in this study in a more graphic way than could be done by a comparison of quantities only, certain unit costs are said to apply fairly well to conditions in New Jersey and are as follows: Cement, 60 cents per bag; sand, 50 cents per ton, and coarse aggregate $1.40 per ton. The resulting material costs per cubic yard are shown in figures 10 and 11. Note the relative high cost resulting from the use of gradings 2, 5, 8 and 12 of series A. The value for grading No. 2 crushed stone is evidently in error as this point should be considerably higher than shown. On the basis of the above unit prices, the average cost of materials for 1 cubic yard of gravel concrete 1:1¾:3½ mix by volume is $5.38, while the corresponding value for the crushed stone concrete is $5.70, an increase of 32 cents, or approximately 6 per cent. These values and those for series B, together with the corresponding moduli of rupture are given in Table 17. Values

TABLE 13.—*Quantities of material required for 1 cubic yard of concrete, using the proportions 1:1¾:3½ by volume (nominal mix, series A)*

Coarse aggregate grading No.	Stone			Gravel		
	Cement	Sand	Stone	Cement	Sand	Gravel
	Bags	*Pounds*	*Pounds*	*Bags*	*Pounds*	*Pounds*
1	6.1	1,160	2,350	5.9	1,120	2,230
2	6.4	1,210	2,180	6.2	1,190	2,120
3	6.3	1,190	2,330	5.9	1,120	2,210
4	6.3	1,200	2,290	5.7	1,080	2,160
5	6.8	1,280	2,230	6.2	1,200	2,140
6	6.2	1,170	2,220	5.7	1,090	2,140
7	6.2	1,180	2,250	5.8	1,100	2,140
8	6.5	1,230	2,220	6.1	1,160	2,080
9	6.2	1,170	2,250	5.8	1,100	2,180
10	6.3	1,200	2,160	5.8	1,100	2,140
11	6.4	1,220	2,210	5.9	1,110	2,130
12	6.6	1,250	2,170	6.2	1,170	2,110
13	6.6	1,260	2,090	6.1	1,150	2,060
Average ..	6.4	1,210	2,230	6.0	1,130	2,140

may be calculated in a similar way for any combination of unit prices.

Yield of Series B

Data for quantities of material used and densities of concrete as determined for series B are shown in Tables 15 and 16. The quantities and corresponding costs are plotted in Figures 8, 9, 10 and 11 and Table 17. These data show approximately the same relative difference in cost between the gravel and the stone concrete as in series A. It is interesting to note, however, that one factor which produces high costs in concrete proportioned as in series A, has just the opposite effect when proportioning is by the water-cement ratio trail method. When a contractor is working under a straight water-cement ratio specification, and sand is cheaper than coarse aggregate, as in this case, it is to his advantage to use a poorly grading stone or gravel because in so doing he is able to crowd more aggregate into his cement

TABLE 14.—*Solid volumes of material for 1 cubic yard of concrete for each mix of series A and total solids or density of concrete expressed as a percentage of maximum possible density*

Coarse aggregate grading No.	Stone				Gravel			
	Solid volumes			Total Solids	Solid volumes			Total Solids
	Cement	Sand	Stone		Cement	Sand	Gravel	
	Cu. ft.	*Cu. ft.*	*Cu. ft.*	*Per ct.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Per ct.*
1	2.96	7.04	12.70	84	2.86	6.79	13.52	86
2	3.11	7.33	11.78	81	3.01	7.21	12.84	85
3	3.06	7.22	12.60	85	2.86	6.79	13.40	85
4	3.06	7.27	12.38	84	2.77	6.54	13.10	83
5	3.30	7.76	12.05	86	3.06	7.27	12.98	86
6	3.01	7.09	12.00	82	2.77	6.61	12.98	83
7	3.01	7.15	12.17	83	2.82	6.67	12.98	83
8	3.16	7.45	12.00	84	2.96	7.03	12.60	84
9	3.01	7.09	12.17	83	2.82	6.67	13.21	84
10	3.06	7.27	11.68	81	2.82	6.67	12.98	83
11	3.11	7.30	11.94	83	2.86	6.73	12.91	83
12	3.21	7.58	11.72	83	3.01	7.09	12.79	85
13	3.21	7.64	11.30	82	2.96	6.97	12.49	83

paste before passing the bounds of workability. On the other hand, the high cost of using a grading such as No. 10 with a large proportion of relatively small sizes is at once apparent, especially with the smaller proportions of sand.

Slabs of Equivalent Strength

It is of interest to compute the relative theoretical thicknesses of slab required to produce pavements of equivalent transverse strength, using the average values of modulus of rupture for the two classes of concrete as shown by the tests of series A. For this purpose the so-called corner formula, which is used extensively in the calculation of edge thickness for concrete pavement slabs, is employed. This formula is usually expressed as follows:

$$d = \sqrt{\frac{3P}{s}}$$

In which d = depth of slab in inches;
s = allowable unit flexural stress in bending in the concrete; and
P = allowed wheel-load at corner in pounds.

TABLE 15.—*Quantities of materials required for 1 cubic yard of concrete, series B*

RATIO OF FINE TO COARSE AGGREGATE 33 : 67

Coarse Aggregate grading No.	Stone			Gravel		
	Cement	Sand	Stone	Cement	Sand	Gravel
	Bags	*Pounds*	*Pounds*	*Bags*	*Pounds*	*Pounds*
1	6.4	1,120	2,320	5.9	1,080	2,180
2	6.1	1,260	2,300	5.7	1,210	2,200
3	6.7	1,150	2,300	6.0	1,080	2,170
4	6.3	1,190	2,300	6.2	1,080	2,200
5	6.3	1,260	2,230	5.8	1,170	2,120
6	7.0	1,130	2,170	6.4	1,050	2,100
7	6.8	1,130	2,190	6.0	1,080	2,130
8	6.2	1,210	2,210	5.8	1,160	2,120
9	6.4	1,140	2,250	5.9	1,080	2,180
10	7.3	1,140	2,080	6.7	1,050	2,080
11	6.9	1,170	2,150	6.2	1,080	2,100
12	6.7	1,210	2,140	6.1	1,180	2,170
13	7.0	1,220	2,060	6.3	1,130	2,040
Average	6.6	1,180	2,210	6.1	1,110	2,140

RATIO OF FINE TO COARSE AGGREGATE 36 : 64

1	6.6	1,240	2,230	6.0	1,190	2,100
2	6.3	1,340	2,140	5.8	1,280	2,030
3	6.8	1,240	2,160	6.0	1,190	2,100
4	6.4	1,280	2,180	6.0	1,180	2,100
5	6.2	1,340	2,080	5.9	1,270	2,020
6	7.0	1,220	2,060	6.3	1,140	2,000
7	6.4	1,260	2,130	6.1	1,160	2,010
8	6.2	1,310	2,100	6.0	1,250	2,000
9	6.1	1,250	2,160	6.0	1,160	2,060
10	7.4	1,220	1,960	6.8	1,120	1,930
11	6.8	1,270	2,040	6.3	1,180	2,000
12	6.4	1,320	2,040	6.4	1,240	1,980
13	6.8	1,320	1,950	6.6	1,220	1,940
Average	6.6	1,280	2,100	6.2	1,200	2,020

RATIO OF FINE TO COARSE AGGREGATE 40 : 60

1	6.9	1,340	2,020	6.4	1,300	1,940
2	6.4	1,440	1,940	6.5	1,380	1,860
3	6.8	1,360	2,000	6.2	1,300	1,920
4	6.6	1,380	1,980	6.0	1,290	1,930
5	7.0	1,440	1,880	5.9	1,380	1,860
6	6.8	1,350	1,920	6.2	1,280	1,880
7	6.8	1,330	1,910	6.2	1,260	1,840
8	6.6	1,430	1,940	6.2	1,350	1,820
9	7.0	1,320	1,920	6.2	1,260	1,870
10	7.4	1,340	1,800	6.5	1,260	1,830
11	6.7	1,400	1,900	6.5	1,280	1,840
12	6.5	1,440	1,890	6.2	1,360	1,840
13	7.0	1,440	1,800	6.4	1,340	1,790
Average	6.8	1,390	1,920	6.3	1,310	1,860

In both cases the usual maximum allowable unit stress of one-half the modulus of rapture will be employed in the calculation. In the case of the gravel concrete this gives an allowable stress of 253 pounds per square inch and for the stone concrete a corresponding value of 285 pounds per square inch. Assuming a load at the corner of 8,000 pounds in each case, the value of d for the crushed-stone concrete reduces to 9.18 inches and for the gravel concrete to 9.74 inches, an increase of 0.56 inch, or 6.1 per cent. For equivalent slab strengths and on the basis of the flexural-strength values in the concrete obtained from these test, pavements constructed of gravel concrete should be approximately one-half inch thicker than pavements constructed of crushed-stone concrete.

Reverting again to the previously assumed unit costs and adding 6.1 per cent to the cost of 1 cubic yard of gravel concrete as shown as $5.38, a value of $5.71 is obtained, which is almost exactly equal to the unit cost per cubic yard of the stone concrete. In other words, for the unit prices assumed, the cost of materials required to produce concrete pavements of the same slab strength is almost exactly the same for both aggregates. A similar cost analysis may, of course, be made with any other combination of unit prices. For example, assuming cement at 50 cents per bag, sand and gravel at $1.20 per ton, and crushed stone at $1.40

TABLE 16.—*Solid volumes of material for 1 cubic yard of concrete for each mix of series B and total solids or density of concrete expressed as a percentage of maximum possible density*

RATIO OF FINE TO COARSE AGGREGATE 33 : 67

Coarse aggregate grading No.	Stone				Gravel			
	Solid volumes			Total solids	Solid volumes			Total solids
	Cement	Sand	Stone		Cement	Sand	Gravel	
	Cu. ft.	*Cu. ft.*	*Cu. ft.*	*Pct.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft*	*Pct.*
1	3.11	6.79	12.54	83	2.86	6.54	13.51	84
2	2.97	7.64	12.42	85	2.77	7.34	13.34	87
3	3.26	6.97	12.42	84	2.91	6.54	13.15	84
4	3.08	7.22	12.42	84	3.01	6.54	13.34	85
5	3.06	7.64	12.05	84	2.81	7.10	12.85	84
6	3.40	6.85	11.74	82	3.11	6.36	12.71	83
7	3.30	6.85	11.84	81	2.91	6.54	12.91	84
8	3.01	7.33	11.95	83	2.81	7.03	12.85	84
9	3.11	6.97	12.16	82	2.86	6.54	13.20	84
10	3.54	6.91	11.25	80	3.25	6.36	12.60	82
11	3.35	7.09	11.62	82	3.01	6.54	12.71	82
12	3.25	7.34	11.56	82	2.96	7.15	13.16	86
13	3.40	7.40	11.13	81	3.05	6.84	12.36	82

RATIO OF FINE TO COARSE AGGREGATE 36 : 64

1	3.21	7.52	12.06	84	2.91	7.22	12.73	85
2	3.06	8.12	11.57	84	2.82	7.76	12.30	85
3	3.30	7.52	11.67	83	2.91	7.22	12.73	85
4	3.11	7.76	11.79	84	2.91	7.16	12.73	85
5	3.01	8.12	11.24	83	2.86	7.70	12.24	84
6	3.40	7.40	11.14	81	3.06	6.91	12,12	82
7	3.11	7.64	11.51	82	2.96	7.03	12.18	82
8	3.01	7.94	11.36	83	2.91	7.58	12.12	84
9	2.96	7.58	11.68	82	2.91	6.91	12.48	83
10	3.60	7.40	10.60	80	3.30	6.79	11.70	81
11	3.30	7.70	11.03	82	3.01	7.15	12.12	83
12	3.11	8.00	11.03	82	3.11	7.52	12.00	84
13	3.30	8.00	10.54	81	3.21	7.39	11.75	83

RATIO OF FINE TO COARSE AGGREGATE 40 : 60

1	3.35	8.12	10.91	83	3.11	7.88	11.75	84
2	3.11	8.73	10.49	83	3.16	8.36	11.27	84
3	3.30	8.24	10.81	83	3.01	7.88	11.64	83
4	3.20	8.36	10.70	82	2.91	7.82	11.69	83
5	3.40	8.73	10.16	83	2.86	8.36	11.27	83
6	3.30	8.18	10.38	81	3.01	7.76	11.39	82
7	3.30	8.06	10.32	80	3.01	7.64	11.15	81
8	3.20	8.67	10.49	83	3.01	8.18	11.03	82
9	3.40	8.00	10.38	81	3.01	7.64	11.33	81
10	3.59	8.12	9.73	79	3.16	7.64	11.09	81
11	3.26	8.49	10.27	82	3.16	7.76	11.15	82
12	3.16	8.73	10.21	82	3.01	8.24	11.15	83
13	3.40	8.73	9.73	81	3.11	8.12	10.85	82

TABLE 17.—*Average costs per cubic yard of concrete, series A and B*

Series	Coarse Aggregate	Ratio of fine to coarse aggregate	Cost of concrete per cubic yard	Average modulus of rupture 28 days
A	Stone	33:67	$5.70	570
	Gravel	33:67	5.38	505
B	Stone	33:67	5.80	580
	Gravel	33:67	5.45	525
	Stone	36:64	5.75	590
	Gravel	36:64	5.40	525
	Stone	40:60	5.75	580
	Gravel	40:60	5.40	515

Cost based on the following assumed unit prices: Cement, $0.60 per bag; sand, $0.50 per ton; coarse aggregate, $1.40 per ton.

TABLE 8.—*Shovel movements classified according to time required*

Time required (seconds)	Movements of crawler-traction shovels	Movements of wheel-traction shovels operating on mats	Time required (seconds)	Movements of crawler-traction shovels	Movements of wheel-traction shovels operating on mats
	Number	Number		Number	Number
8 to 10	6	..	50 to 60	2	5
10 to 12	29	..	60 to 70	1	12
12 to 14	32	..	70 to 80	..	28
14 to 16	20	..	80 to 90	2	7
16 to 18	14	..	90 to 100	..	10
18 to 20	8	..	100 to 125	..	16
20 to 25	23	..	125 to 150	..	7
25 to 30	10	..	150 to 175	..	4
30 to 35	7	..	175 to 200	..	1
35 to 40	8	..	Above 200	..	6
40 to 50	6	3			

per ton, the unit cost of a cubic yard of gravel concrete (series A) is found to be $4.96, with $5.49 as the corresponding cost for the stone concrete, an increase of 53 cents. In this case, adding 6½ per cent to the cost of the gravel concrete to care for the added thickness, makes the total cost of material in a gravel concrete slab of equivalent strength $5.26 as against $5.49 for the stone concrete.

These figures are given solely to illustrate how fluctuations in material prices affect relative costs and not with any idea that they may be applied to any specific conditions. It should also be noted that, theoretically, there will be a somewhat higher labor cost in placing the gravel due to its extra thickness, although this item might possibly be somewhat neutralized by the greater workability of the gravel concrete as compared with the crushed-stone concrete.

Conclusions Presented

It is not intended that the conclusions given below and which are based on the results of these tests shall be considered as applicable to crushed trap rock and gravel of a different type and quality than those employed in this investigation, or to kindred aggregates produced and marketed under conditions differing from those used, and should not be interpreted as applying to crushed-stone or gravel aggregates in general. These conclusions are as follows:

1. That when coarse aggregates comparable in quality to those used in these tests are employed in the construction of concrete pavements in New Jersey under existing specifications:

(a) Concrete in which crushed trap rock is used as coarse aggregate will average about 12 per cent higher in flexural strength than concrete in which gravel is used as coarse aggregate.

(b) There will be practically no difference in the crushing strength of crushed trap-rock concrete and gravel concrete.

(c) There will be practically no difference in the absorption of crushed trap-rock concrete and gravel concrete.

(d) For equivalent flexural slab strengths, a pavement constructed of gravel concrete should have a depth approximately one-half inch greater than a pavement constructed of crushed trap-rock concrete.

(e) The cost of the materials required for a unit volume of crushed trap-rock concrete will as a rule be greater than the cost of materials required for an equivalent volume of gravel concrete.

2. That when coarse aggregates comparable to those used in these tests are used in concrete mixtures designed for a given strength by the so-called water-cement ratio trial method:

(a) The flexural strength of the crushed trap-rock concrete will average about 11 per cent higher than the gravel concrete.

(b) There will be practically no difference in the crushing strength of the crushed trap-rock concrete and the gravel concrete.

In addition to the above, the following indications as to effect of gradation on strength and yield when the concrete is proportioned by fixed volume as well as by the water-cement ratio theory may be stated:

(1) That the gradation of the coarse aggregate has very little direct effect upon the strength of the concrete.

(2) That when proportioned by the water-cement ratio trial method, variations in the fine-coarse aggregate ratio of from 1:2 to 2:3 do not affect the strength of the concrete for a given sand and for a given water-cement ratio.

(3) That variation in coarse aggregate grading will greatly affect the yield of concrete and therefore its cost, when the concrete is proportioned either in the usual way or by the water-cement ratio method.

(4) That the use of well-graded coarse aggregate will increase the yield when proportioned by the usual method, but exactly the reverse is the case when the concrete is proportioned by the water-cement ratio method.

Building Construction Increases

Construction contracts to the amount of $592,567,000 were awarded last month in the 37 states east of the Rocky Mountains, according to F. W. Dodge Corporation. The above figure covers about 91 per cent of the total construction of the country. Last month's total was the highest monthly contract total on record for the 37 States since June 1927. There was an increase of 27 per cent over the total for February of this year, but there was a drop of 5 per cent from the March 1927 record.

Last month's record brought the total amount of new construction started since the first of this year in these states up to $1,485,067,000, being an increase of 6 per cent over the amount started in the first quarter of last year. In addition to being ahead of last year's first quarter record it was the highest first quarter ever recorded for the 37 States.

Analysis of the March contract total showed the following important classes of work: $275,191,600, or 46 per cent of all construction, for residential buildings; $110,338,200, or 19 per cent, for public works and utilities; $73,075,300, or 12 per cent, for commercial buildings; and $33,881,000, or 6 per cent, for educational projects.

New work contemplated during the past month amounted to $884,609,100, which was 7 per cent less than the amount reported in the preceding month.

A VOUCHER SYSTEM AND ITS ADVANTAGES

By J. J. Berliner

THE purpose of a voucher system is to make it possible to record expenditures before being paid, through the use of numbered vouchers, thus doing away with the use of creditor's ledgers. In moderate and large sized concerns, especially where the policy of securing bids on all purchases is followed, resulting in a constant changing of firms from whom purchases are made and no regularly established trade with any of them, or where purchases are made from a large number of concerns, the burden of handling the accounts payable or creditors' ledger becomes an increasingly heavy one with little or no gain in desirable information furnished by it. Accordingly, the voucher system has developed which eliminates the necessity of opening regular accounts with every creditor, but instead makes every transaction, whether one or many were entered into with the same individual, independent of all others. This makes possible the showing of the settlement of that transaction in the place where its original record was made, without opening up a ledger account for it.

In the general sense, a voucher is a statement which certifies the correctness of a transaction. A voucher consists of a "voucher jacket" and the "filling"—that is, a folded sheet on the inside of which are attached the papers that pertain to the transaction, the "distribution" being usually recorded on the outside of the jacket. A voucher must provide for a statement of the bill of which payment is being made and a place for acknowledgement of receipt of payment by the payee. Usually provision is made also for: (1) certification of the correctness of the bill by properly authorized house employees and its approval for payment; and (2) a proper distribution on the accounting records of the payments authorized, i. e., an official determination of the debit and credit entries to be made on the books. (See different forms of vouchers.)

How the Voucher System Operates

When the invoice covering any purchase is received, it is held until the goods purchased arrive. After the proper inspection and acceptance of the goods, a voucher made out in duplicate on which is written a copy of the invoice, with the cash discount, if any, shown deducted is prepared by a voucher clerk for each bill or group of bills from one creditor that is to be paid for. Vouchers are given consecutive numbering just like checks. If immediate payment is to be made, the voucher will be "approved" and check drawn for the amount. Promptness in preparing and recording vouchers is a necessary feature of a voucher system, as well as the accuracy with which they are prepared. The following is a summary of the responsibilities surrounding the payment of any bill:

(a) Checking the original authority for the purchase or expense.
(b) Verifying the agreed price of purchase.
(c) Verifying the agreed amount of purchase.
(d) Comparison of the quantity actually received with the quantity per invoice.
(e) Checking the clerical accuracy of the invoice.
(f) Distribution.
(g) Computing discount to be taken.
(h) Entry in the voucher record.
(i) Authorization of payment.
(j) Preparation of the check.
(k) Making certain that the invoice has not been paid previously.

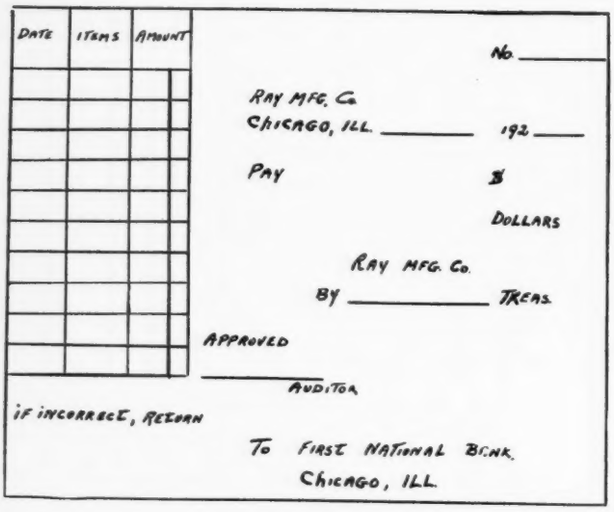
The voucher with a check attached is sent to the creditor with a request that he receipt the voucher and return it. However creditors are not as a rule particularly interested in helping another concern keep its books and as a result, a large number of vouchers are destroyed. It is here that the duplicate copy retained in the files serves to keep the file of vouchers complete, though it does not, of course, constitute a receipt of the payment.

The Voucher Check

The difficulty in securing prompt return of receipted vouchers has led to the adoption of combined voucher and check called a "voucher check." The indorsement on the check, which is necessary for its collection (the bank will not pay without endorsement), serves at the same time as a receipt of the bill.

There are two forms of voucher checks in use, the folded check and the single. (See illustration.) It may be a combination voucher and check, usually folded once lengthwise or it may be similar to an ordinary check, differing only in that on the left or on the back appear the details of the payment. It may be prepared in duplicate, the original sent to the creditor, and the duplicate retained as a voucher jacket. Its chief advantage lies in the fact that the creditor receives the details of a payment without a further letter of transmittal. The distribution, of course, need appear on the duplicate only.

The single form of check can be used when a detailed statement of invoices is not desirable or when invoices carry but few items. Such a voucher check is sometimes also used for the payment of dividends to stockholders and does away with the need of a formal receipt or of signature in the dividend book.



Voucher Check—Single

Voucher Register

The "Voucher Register" or the "Accounts Payable Register" as it is sometimes called is the book (of original entry) in which the voucher and its distribution are recorded. It is a book containing as many columns as are required for specific charges and a sundry column for accounts not requiring special columns. In the illustration of a voucher register shown (which see) the columns are divided as follows: In the first three columns are to be entered the date of the voucher, its number, and the name of the party from whom the purchase has been made. In the next column is entered the explanation of the terms on which the goods are bought as for example one per cent 10 days, net 30 days, meaning that 1 per cent can be taken if paid within 10 days, or if held 30 days, net. The total amount of the voucher is entered in the next column headed "Vouchers Payable" or sometimes called "Accounts Payable." The purchase discount column records the cash discounts taken in paying. The other columns are for the distribution of the various kinds of expenditures in such a way as to facilitate their postings and entries to the general ledger. The decision as to whether or not to have a column for a group of items depends on how frequently these items appear. If they must be recorded at brief intervals so that there are a large number during a month, then it is usually wise to have a column especially for them.

Posting of Summary Totals

At the end of the month, or oftener if desired, the voucher register is summarized and posted. This is accomplished in the following manner:

1. All columns are totaled and the voucher register is balanced. Balancing consists of seeing that the combined totals of all the distribution columns are equal to the totals of the Vouchers Payable columns plus the Discount column.

2. The total of each money column, except the Miscellaneous column is posted to its respective ledger account, the ledger page number being shown at the left of the total, or, if there is not room in that space, just above the total. The items in the Miscellaneous column are posted individually to the respective ledger accounts.

Proof of distribution should always be secured by checking the total of the distributive column totals against the total of the Vouchers Payable column. In posting, the total of the Voucher Payable column is credited to its account, while the totals of the distributive columns are charged to their respective accounts.

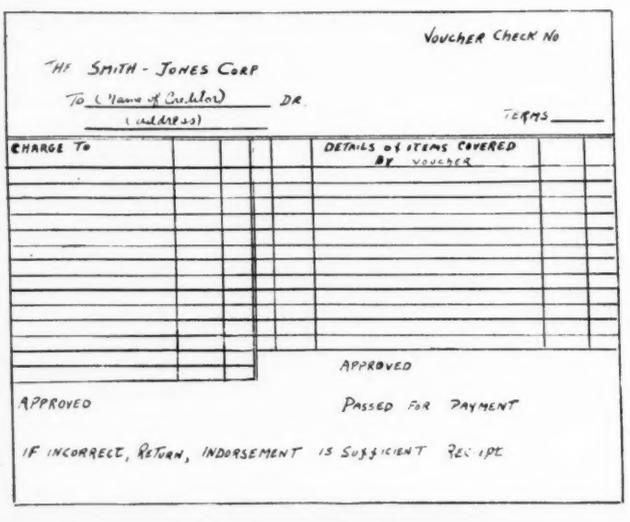
Effect on Cash Book

The advantages of this periodic posting of expense colmn totals as compared with the detailed posting of such items from the cash book as required under the old method (without the voucher system) is apparent. The cash book is in this way relieved of all need of naming the account to be charged for each detailed entry, the proper charge having been made from the voucher register. If every transaction which will ultimately give rise to a disbursement of cash is vouchered and therefore recorded through the voucher register, there is really no need of a detailed entry of the checks on the cash book, for only their total is posted.

Sometimes, to facilitate reconciliation with the bank account, the voucher checks are given a new series of numbers known as treasurer's numbers when issued in payment of invoices. Where this is done, the cash book shows entry of all checks in the numerical sequence of treasurer's numbers, just as entry in the voucher record is in the sequence of voucher numbers. Some checks are held before issue longer than others due to different lengths of credit term, etc.: justifying the need for this new series of numbers.

Payment of Vouchers

After the preparation and entry of the voucher



Voucher Check—Double Reverse

into the voucher register. if payment is to be made at once, it is passed for payment by the treasurer or other fiscal officer and the check is drawn and issued. Any cash discount taken should be shown deducted on the face of the invoice, the check carrying the net amount. Where payment is to be made at later period, but at the same time the terms of credit necessary for discount is to be observed, the voucher should be filed away in a tickler file which will automatically bring it up for attention at the proper time. The original invoice is placed in a temporary file, arranged alphabetically, until paid, when it may be removed and filed permanently with the paid voucher. Upon a payment of the voucher, the check is entered along the cash disbursements, and a notation is marked in the payment column of the voucher register, showing the date and in what manner payment was made.

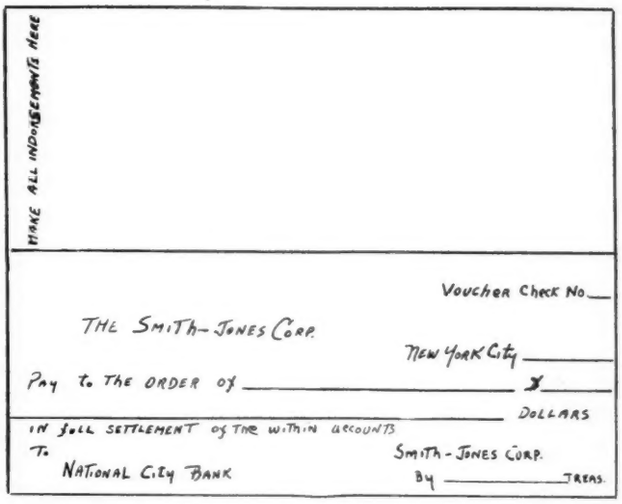
For the proper operation of the voucher system, an alphabetic index of creditors must be made up on which should be shown the voucher numbers relating to transaction with each creditor. This is usually of the card index type, each creditor being provided with a card on which is noted a list of the vouchers recording the business done with him. This voucher index, while not a ledger in the accepted sense, serves all the essential purposes of a creditors, or accounts payable ledger, when it is operated in connection with the payment column in the voucher register. Morover, the use of the "Unpaid vouchers" column secures at the end of the month the detail of the summary account, Vouchers Payable, carried on the general ledger.

Canceling Vouchers

It is often necessary to cancel certain vouchers which have been made out and entered in the voucher register. Examples of such occasions would be where goods are returned or where it was found inconvenient to meet the payment as vouchered and a note or notes were given creditors. In cases of this kind the original voucher must be canceled and the amount deducted from the amount entered in Vouchers Payable columns and the Distribution of columns. This may be accomplished in two ways.

1. By showing the date of the cancellation column and by making a red ink entry on the same line with the original record of the voucher, the red figures being considered deductions at the time the columns are totaled.

2. By making no entry in the voucher register except that of showing the date in the cancellation column, the original entry giving the reason for the cancellation's being made in the general journal.



Voucher Check—Double

Purchase Returns and Allowances

If the goods can be inspected and accepted or ad-

VOUCHER REGISTER

FACTORY EXPENSE	SALES SALARIES	SELLING EXPENSE	OFFICE SALARIES	OFFICE EXPENSE	MISC CHARGES	ACCOUNT TO BE CHARGED	PAYMENT DATE	PAYMENT MANNER	UNPAID VOUCHERS

Voucher Register, Right Hand Page

INDORSEMENTS	INVOICES			DEDUCTIONS			NET AMOUNT
	DATE	NUMBER	AMOUNT	DATE		AMOUNT	
	TOTAL			TOTAL			
		ENTERED					

FOLD ON THIS LINE DO NOT DETACH THIS ACKNOWLEDGMENT IS SUFFICIENT

SAHAS BROS

THE EMPIRE TRUST CO _____ 192 NO. _____

PAY TO THE ORDER OF _____ $ _____

_____ DOLLARS

APPROVED TREASURER

This Voucher Check is to be Folded Lengthwise

justment secured when necessary before the voucher for the transaction is made up, then the amount to be paid is always the amount of the voucher and no change need be made in the amounts entered and distributed on the voucher register. Where this is done a Purchase Returns and Allowances Account is not required. This procedure, however, is not always possible, for a first inspection does not always show the true condition of goods. Adjustment of the general ledger accounts could be made by entry of the return or allowance through the general journal. That would not, however, leave any indication in the voucher register record of the fact that cancellation of the liability there shown was made by payment of a lesser amount than the one entered, and it is desirable that these two amounts be the same.

To accomplish this, entry of the allowance should be made, in small red ink figures on the upper part of the line just below the vouchers affected, entering in red the voucher number—the same as the voucher to which it applies—and the amount of the allowance, both in the Vouchers Payable column and the distributive columns affected by the allowance. These red ink items are, of course, deductions, the summary amounts of the various columns being net totals, i.e., the totals of regular items less the red figures; or two totals may be shown, one above the other, the regular and the red. Where both black and red totals are shown, both must be posted, the red as contras or offsets to their corresponding black postings. If desired, separate Purchase and Allowances Accounts may be opened.

Partial Payments

The whole voucher system is built on the idea that each voucher is the unit according to which the record is kept. It, therefore, presupposes settlement in full of each voucher; otherwise, the efficient operation of the system is interfered with. Settlement in full is not always possible, however. Since provision is made in the voucher register for but one line on which to show payment of the voucher, it is not possible to indicate partial payments in the allotted space, nor would such practice be desirable.

Where partial payments are to be made, the original voucher must be cancelled in full and two new vouchers issued in place of it—the one for the amount of the partial payment, which will thus cancel it, and the other for the unpaid balance, which will remain open until paid in full or till other partial payment is made. In the latter case the same procedure of cancellation and issuance in its stead of two vouchers must be repeated. This process of cancellation by the reissue of two new vouchers may be effected directly on the face of the voucher register by a full cross-reference between the old and the new, usually shown in the Manner

VOUCHER REGISTER

DATE	VOUCHER NO.	CREDITOR	EXPLANATION	VOUCHERS PAYABLE	PURCHASE DISCOUNT	RAW MATERIALS	FREIGHT CARTAGE	DIRECT LABOR	INDIRECT LABOR

Voucher Register, Left Hand Page

of Payment column; or it may be done by entry on the general journal, which will then constitute the authority for the transaction.

Handling of Notes Payable

If a note is given or a draft accepted upon the purchase of goods, the liability for it will appear on the books only as a note liability, provided the purchase is recorded through some other medium than the voucher register. This medium might be the general journal or the notes payable journal. If, however, original entry of the purchase is made in the voucher register, liability for it is thereby created under the account title, Vouchers Payable. This must be shown canceled by the creation of a note liability in its place, by entry in general or notes payable journals. If the voucher system is used, the check on the original voucher must be canceled by marking it "Void," or by running it through the bank with the day's deposits. In either case for the sake of a complete record of check numbers, it should be entered among the cash disbursements. From all this it is evident that less work is entailed and just as complete a record made by entering the purchase originally in general or notes payable journal as suggested above.

Voucher System Operation and Advantages

The operations and advantages may be briefly summed up as follows:

1. All invoices are verified and checked.
2. Vouchers are prepared for all invoices and entered.
3. Vouchers are filed previous to payment.
4. Paying of Vouchers.
5. Paid vouchers are filed.
6. Vouchers are indexed.

Some of the advantages of a Voucher System are:

1. Gives a detailed analysis of all purchases.
2. Saves a great deal of labor eliminating the creditors of accounts payable ledger.
3. It secures an up-to-date entry of all liabilities.
4. It localizes responsibility by showing authority for the auditing, paying, and entering of the items.
5. It secures a receipted bill for all disbursements of cash.

Prehistoric Oysters

On the banks of the lower Potomac River at Wailes Bluff, near Cornfield Harbor, Md., may be seen a thick bed of oyster shells, now high and dry above tide level and covered by several feet of earth. How did they get there? Is it a kitchen midden of the long ago, left by the Indians or their predecessors? Geologists say no; the bed is vastly older than that, and the oysters lived and died where they now are and owe their present high position to changes in water level and not to human agency.

This ancient oyster bed and adjacent deposits that include a more varied assortment of shells are pictured by W. C. Mansfield in a short report entitled "Notes on Pleistocene Faunas from Maryland and Virginia and Pliocene and Pleistocene Faunas from North Carolina," just published by the Department of the Interior as Professional Paper 150-F of the Geological Survey. Although the oysters that inhabited these shells lived during the final stages of the "Ice Age," the temperature of the sea must have been about the same then as to-day, or perhaps a little warmer, for Mr. Mansfield finds that a kind of clam that now flourishes in Mobile Bay then lived near the mouth of the Potomac River.

In the course of his field studies Mr. Mansfield observed cypress stumps 6 to 8 feet in diameter buried beneath 22 feet of sea shells, sand, and clay, on the Neuse River below New Bern, N. C. He infers that the salt water of the ocean invaded a cypress swamp at this point, killed and truncated the trees, and deposited sand, sea shells, and mud upon them. This was in the later part of what geologists call them Pleistocene epoch, which began perhaps 1,000,000 years or more ago. The stumps may be as much as 100,000 years old. Later the sea withdrew, and the marine deposits were gradually cut through by the river.

New Italian Standards

New standards were issued November, 1927. No definition for Portland cement, as a large proportion of Italian cement is natural. The standards are: I. Fineness of division—2% residue on a 900 mesh sieve. 20% on the 4900 mesh sieve. II. Specific gravity—3.00. III. Setting time for rapid setting cements—beginning after 10 minutes, ending after 30 minutes. For normal cements, beginning of set after one hour, end after 6 to 12 hours. IV. Determination of the volume constancy should be made with test slabs 10-15 cm. diameter and 1-2 cm. thick instead of with test spheres as previously. V. The strength tests allow for two varieties of cement, the rapid hardening and the normal, instead of only one as in previous standards. VI. Added requirements to the chemical composition are: The cement must not contain more than 1.5% sulphur trioxide or more than 3% Magnesium oxide. H. Dewidels (Zement, February 23, 1928).

Neatly Compiled

Claude Rodaunel, superintendent of the Oklahoma Portland Cement Company, Ada, Oklahoma, makes the following statement: "Please accept my thanks for the Hand Book of Pit and Quarry for 1928. It is neatly compiled and we will be able to obtain considerable valuable information from it."

SOME INTERESTING EXPERIMENTS WITH GYPSUM

By P. P. Budnikoff

GYPSUM is a very interesting product not only from the physical and technical standpoints but also from the practical viewpoint as well. When gypsum is heated to any temperature between 107 and 170 degrees C, the greater portion of the water contained in the substance (its formula is $CaSO_4 . 2H_2O$) is removed, the gypsum becomes dull in luster and white in color. It nevertheless still contains a half a molecule of water. Such gypsum is known as plaster of Paris and consists of the most part of the semi-hydrate, $CaSO_4 . \frac{1}{2}H_2O$. When plaster of Paris is stirred with water, it absorbs water over a definite period of time, up to thirty minutes, and this takes place with the evolution of heat, causing rise in temperature, and increase in volume amounting to a maximum of one per cent. When gypsum is heated between a temperature of 170 and 200 degrees C, it still contains a little water, but consists essentially of the so-called soluble anhydrite, $CaSO_4$. When this substance is mixed with water, it sets rapidly. When gypsum is heated between a temperature of 200 and 250 degrees C, then it still contains traces of water, but the time of setting is prolonged. Gypsum is obtained in the strictly water-free condition when it is heated between the temperatures of 400 and 750 degrees C. It then consists of the so-called insoluble anhydrite, $CaSO_4$. The setting of this substance is so slight and so slow that it must actually be considered as a substance that does not possess setting properties, in other words, a "dead-burnt" substance. When the gypsum is heated to incandescence at temperatures in excess of 750 degrees C, then it begins to agglomerate into compact masses, this action taking place slowly and being due to the small amount of water it contains. The products that are obtained under these conditions are hard and very resistant to weathering. Such a product is called hydraulic gypsum or Keene's cement.

It is thus evident that there are several modifications of gypsum, varying from the dihydrate, a product occurring in Nature and very stable, through the semi-hydrate to the water-free anhydrite of which there are two forms, one soluble and the other insoluble.

The general conditions controlling the existence of the hydrates of gypsum differ from the ordinary. Complications ensue due to the fact that there is no exact transition point between the various hydrates, which means that the corresponding curves cannot be definitely established. The phase rule alone gives only little information when studying the system $CaSO_4 + H_2O$. Within the temperature range from zero to 110 degrees C, all four phases, namely $CaSO_4 . 2H_2O$, $CaSO_4 . \frac{1}{2}H_2O$, $CaSO_4$ soluble and $CaSO_4$ insoluble, can exist together. There is no constant region of existence for any hydrate. On the other hand the substance $CoSO_4 . \frac{1}{2}H_2O$ has a special position, due to the fact that the transformation from gypsum, $CaSO_4 . 2H_2O$, into soluble or insoluble anhydrite, $CaSO_4$, takes place at a point below the transition point into semihydrate.

According to van't Hoff, the dihydrate is transformed into the insoluble anhydrite at a temperature of 66 degrees C, the dihydrates into the soluble anhydrite at a temperature of 89 degrees C and into the semihydrate at a temperature of 107 degrees C.

The temperatures, which are given by van't Hoff, are the theoretical transition points of the different modifications one into the other. The facts that the technical man has to face are, however, much more complicated. The transition points are not so sharply defined. The transformations take place only gradually and slowly. Many modifications exist far into the regions where only the others are supposed to exist. The aforegiven data is consequently of slight importance only to the practical man, who is investigating the setting conditions of gypsum and who desires to establish a theory in order to explain the relationship that exists between the setting, the temperatures, the duration of burning, and other factors.

Setting of the Semihydrate

When the dehydrated, so-called plaster of Paris, which consists in main of the semihydrate, is examined under the microscope in a drop of water, the following is observed. Active crystallization sets in within five to six minutes after the drop of water is added, and the crystallization effect is completed within a period of thirty to forty minutes. The size of the needle-like crystals increases as the semihydrate disappears. The length of the crystals varies between 0.01 and 0.04 millimeter and the width between 0.0017 and 0.0025 millimeter. The same gypsum, which has been ignited at a temperature of 170 degrees C for several hours, crystallizes after three to four minutes and the entire process is completed within thirty minutes. The processes, observed under the microscope which means hydration, solution and crystallization, also take place on the setting of gypsum. The end of setting corresponds to complete conversion of the semihydrate into the dihydrate. The presence of insoluble or soluble anhydrite influences the speed of setting of the gypsum. The hardness of the final product is dependant on the form of crystals, the size of the crystals and their density. The slower the gypsum sets, the larger are the crystals

of the dihydrate. The less water required in making up the mixture, the denser is the poured mass. Detailed investigations of the setting process under the microscope have shown that first a rhombic modification of the dihydrate is formed, which is thereafter converted into a monoclinic form.

The phenomenon of setting of gypsum is explainable through the hydration of the semihydrate and the formation of the hard dihydrate, $CaSO_4 \cdot 2H_2O$. The semihydrate is more soluble than the dihydrate. When the latter dissolves, the former separates out, until the hydration is completed, thus:—

$$CaSO_4 \text{ (hard)} \left\{ \begin{matrix} CaSO_4 \\ 2H_2O \end{matrix} \right. \text{ (solution) } CaSO_4 . 2H_2O \text{ (hard)}.$$

The dihydrate therefore crystallizes from the supersaturated solution, the crystals grow together and partly form a solid solution. Van Glasenapp states that the recrystallization of the semihydrate, more soluble in water, into the dihydrate, less soluble in water, plays the principal role in the hardening of the plaster of Paris obtained at a temperature of 130 to 200 degrees C. This viewpoint has been markedly changed within recent times, due to the work of Kavazzi, Traube, W. Ostwald, Wolski, Neuberg, Rewald and A. Baykow. These experimenters have considered the setting of gypsum to be a colloidal process. The burnt gypsum, made into a paste with water, form a colloid under the influence of the water due to the swelling of the gypsum particles and crystals thereafter are evolved from this solution. A. Baykow says that all setting materials, such as cement, pass through a colloidal state, although after the end of the process the solution consists only of crystalline compounds of considerable solubility in water.

It has been mentioned beforehand that the volume of the gypsum increases during its setting. The advocates of the colloid theory explain this increase in the volume on setting by the separation of crystals from the coagulated gel.

The hydration process of plaster of Paris is exothermic. Soon after the plaster has been mixed with water, and this occurs approximately after one to two minutes, a temperature rise suddenly take place (this moment corresponds to the hydration of the gypsum), and it is then followed by a slight decrease in temperature corresponding to the dissolving of the calcium sulphate) and finally a slow increase in the temperature takes place up to approximately 20 degrees C or more. This results from the setting of the mass in the supersaturated solution. The negative temperature effect during solution is thereby compensated by the important temperature effect during the hydration of the gypsum.

Acceleration and Retardation

Several investigators have already concerned themselves with the study of the effect of accelerators and retarders of the speed of setting. According to Rohland the mechanism of the effect of catalysts on the acceleration or retardation of the setting of gypsum is explained by the greater or lesser pressure of the solution of those substances which hydrate in salt solutions.

The change in the speed of hydration depends not only on the nature of the dissolved substance, but also on the concentration of the solution. According to Rohland, the substances, which promote the solubility of gypsum, act as accelerators and those which reduce the solubility of the gypsum, act as retarders. According to other investigators different electro-positive elements have dissimilar action. When the same base is employed, salts formed with the strongest acids will have the most potent effect. Electro-positive elements particularly allow this observation to be corroborated. Thus the strongest bases are mostly possessed of an accelerating potency.

According to Traube the setting process of gypsum can be accelerated by the addition of electrolytes and is retarded by the presence of colloids. Particularly rapid setting is caused by the presence of univalent ions. Anions are of secondary importance only. Bivalent cathions possess a retarding influence.

The investigations of the author on the influence of normal and molar acid solutions, of their sodium salts, of salts of univalent, bivalent or trivalent metals, of complex salts and bases on the speed of setting of plaster of Paris according to the thermal effect have led to the conclusion that the acids, sulphuric acid, nitric acid, hydrochloric acid and tartaric acid are accelerators. Their catalytic action can be represented in the following manner:—

$$H_2SO_4 > HNO_3 = HCl > C_4H_6O_6.$$

Phosphoric acid, lactic acid, boric acid, formic acid, acetic acid and citric acid are retarders according to the results obtained by the author. The strength of these acids, that is as far as their retarding action is concerned, is as follows in descending series:—citric acid, acetic acid, formic acid, phosphoric acid, boric acid and lactic acid.

The negative action of the organic acids increases with the size and the complexity of their molecule. Lactic acid is an exception to the rule.

Tests were also made with the sodium salts of these acids for the purpose of determining the parallel relationship between the influence of the active acid anion both in acid solution as in neutral or slightly alkaline media (solutions of sodium salts). The twenty-three curves which were obtained gave the result that the sodium salts of sulphuric acid, hydrochloric acid, nitric acid, hydrobromic acid, thiosulphuric acid, etc. accelerate the setting process and hence must be classed amongst the positive catalysts. Their action can be grouped in accordance with the following descending series:

—sodium chloride, sodium nitrate, sodium bromide, sodium chlorate, sodium thiosulphate, sodium sulphate. The positive properties of these salts decrease with increase in their molecular weight. Sodium sulphate is, however, an exception to this rule.

The sodium salts of sulphuric acid, citric acid, tartaric acid, lactic acid, phosphoric acid and acetic acid are retarders. Their retarding action is indicated in the following series in a comparative manner, this action increasing in effectiveness in the order indicated in the series, thus, sodium lactate, sodium phosphate, sodium acetate, sodium citrate and sodium tartrate.

The experiments which were carried out by the author on molar, normal and tenth normal solutions of the carboxylic acids showed that the negative action of these acids on the rapidity of setting of plaster of Paris is so great, that even the tenth normal solutions of the salts of these acids do not give a second increase in temperature. A second temperature rise was observed in the experiment which was carried out with the aid of a tenth normal solution of sodium lactate. The gypsum mass did not set in all the experiments. It was only after a period of twenty hours had elapsed that any appreciable degree of hardening of the gypsum was noticed. The strength of the samples, obtained in this manner, was several times greater than the strength of the gypsum mixture which was prepared with the aid of positive catalysts or with pure water. The gypsum mass set in the experiment which was carried out with a tenth normal solution of sodium lactate, although the surface of the mass was still sticky and soft. Sodium acetate has the effect of loosening up the mass of gypsum and then it remains still in the soft state even after it has been kept for a number of days. The gypsum will not harden when it is prepared with the admixture of sodium phosphate. The surface of the mass becomes covered with a film of finely crystalline substance. The results which were obtained with these experiments, in which negative catalysts were employed, indicated that it is not possible to state in accurate terms that the use of the negative catalyst results in an increase in the strength of the set mass.

Salts of the univalent metals may be classed amongst the strongly positive catalyzers according to their action on the speed of setting. The effectiveness of these salts, that is their accelerating power on the setting of the gypsum, is indicated in the following series. Sodium sulphate, potassium nitrate, potassium chloride, potassium sulphate and lithium sulphate all have the same potency as setting accelerators, and this potency is greater than that of ammonium chloride and silver nitrate. On the other hand ammonium chloride is a more potent agent than silver nitrate which is lowest in the series.

Study of the most advantageous temperature effects in the second increase of the temperature during the setting process and of the composition of the time intervals from the beginning of the experiment to the moment of setting leads to the conclusion that the catalytic behavior of the salts, ammonium sulphate, potassium nitrate, potassium chloride, potassium sulphate and lithium sulphate is the same.

The salts of the bivalent metals may be grouped in the following series of descending potency of action on the setting of plaster of Paris: viz. cadmium sulphate, copper sulphate, zinc sulphate, manganese sulphate, nickel sulphate, ferrous sulphate, magnesium sulphate and cobaltous sulphate.

When the common acid anion is not taken into consideration in studying the substances which are indicated in the above series (this with the exception of the last member of the series), then a new series can be written, which affords a valuable indication of the accelerating activity of the bivalent cathions. The new series is as follows:—cadmium, copper, zinc, manganese, nickel, ferrous ion, magnesium.

The salts of the alkaline earth metals are capable of being arranged in a separate group, for they possess another acid anion and other solution concentrations. In arranging the series of these three alkaline earth metals in accordance with the potency of their catalytic properties, a normal solution was used. The following series was then obtained and the potency of the substance decreases in the order indicated in the series, viz., calcium chloride, barium chloride and strontium chloride, or calcium, barium and strontium.

A study of the results obtained in this investigation has allowed the following conclusions to be drawn. In the first place it is stated that the bivalent metals with sulphate anion differ very slightly amongst themselves as far as their catalytic properties are concerned. They must all be classed amongst the strong accelerators. In the second place it can be established that the most favorable temperature effect in the second stage of temperature increase is very much like the temperature effects of the corresponding salts of the univalent metals. In the third place it has been determined that the catalytic activity is manifested in a slighter degree in the case of the alkaline earth metals with a chlorine anion.

Barium chloride may be classed amongst the positive catalyzers. It can be concluded from a comparison of the experimental results obtained with molar and normal solutions of calcium chloride that this salt is a weaker accelerator. In the form of a molar solution it acts actually like a very weak retarder with a slight negative action. Strontium chloride is a strong retarder. This is particularly noticeable in the experiments made with molar solutions. It is only after a period of one and one-

half hours has elapsed that a slight increase in the temperature is noticed.

It is readily possible to explain the weakly manifested temperature effect in setting of plaster of Paris through a simple double decomposition reaction with the formation of barium sulphate or strontium sulphate, as the less soluble salt. This reaction is shown in the following equation:—

$$CaSO_4 + BaCl_2 = CaCl_2 + BaSO_4.$$

The salts of the trivalent metals can be arranged in the following series of decreasing potency of action, viz., aluminum sulphate, chromium sulphate, ferric sulphate or aluminum, chromium and iron (ferric). The activity of normal solutions of these salts is indicated in the following series, the potency of the solution decreasing in the order of the series, thus, ferric sulphate, chromium sulphate and aluminum sulphate or ferric iron, chromium and aluminum.

The following conclusion is then obtained from consideration of the results obtained from experiments with these salts, namely that the molar solutions of the sulphates of aluminum, ferric iron and chromium have a strong retarding action on the setting phenomenon of plaster of Paris.

The retarding action of these salts is markedly decreased when they are used in normal solution.

In this connection the normal solution of aluminum sulphate acts as a retarder. The negative action of the molar solutions of iron, aluminum and chromium is explained by the fact that the hydrates of aluminum, iron and chromium, which are formed in the colloidal condition, strongly retard the speed of setting of the semihydrate and the positive action of the free sulphate ions is thereby counteracted.

We are now ready to discuss the action of complex salts, such as ferricyanides, ferrocyanides, normal solutions of iron ammonium alum and aluminum ammonium alum. All these four salts, which gave a series of results indicated temperature rise during the setting process, are quite powerful accelerators. A particularly strong positive effect is observed with the normal solutions of the first two salts. These substances may be arranged in the following series of descending potency of catalytic properties, viz., potassium ferrocyanide, potassium ferricyanide, ammonium aluminum sulphate and ammonium iron sulphate.

The normal solutions of the complex salts resemble very closely in their action the molar solutions of sulphuric acid and hydrochloric acid according to their temperature effects and particularly according to the character of the thermal curves.

A number of experiments were also carried out with various alkalies. Of the strong alkalies potassium hydroxide, sodium hydroxide and lithium hydroxide were employed and of the weaker alkalies a saturated solution of milk of lime and a molar solution of ammonia. The results obtained in these tests have enabled the grouping of these substances in the following series according to a descending potency of catalytic action, viz., potassium hydroxide, sodium hydroxide, lithium hydroxide and ammonium hydroxide or potassium, sodium, lithium, and ammonium ion.

The results, which were obtained in this series of experiments, afford the conclusion that the molar solutions of potassium hydroxide, sodium hydroxide, and lithium hydroxide can be considered as accelerators. The tests which were carried out with molar and tenth normal solutions of ammonia indicate that this is a strong retarder. Caustic lime acts like a negative catalyst.

The next interest point is the hydration of the insoluble anhydrite. The experiments of the author have indicated that the hydration of the insoluble anhydrite can be produced with the aid of most different substances. The presence of alkalies, acids, neutral salts and acid salts in slight amounts accelerate this process. The greatest degree of hydration is effected during the same time interval by an addition of sodium bisulphate (see P. P. Budnikoff, Tonindustrie Zeitung, 1926, numbers 7 and 8). The size of the particles plays therefore a very important role. The greater the degree of fineness of the particles, the stronger will be the action of the added substance. The acid salts do not require grinding to so high a degree of fineness as the alkalies or neutral salts. All added substances, which produce hydration of the insoluble anhydrite, act in a catalytic manner. The anhydrite probably forms on the surface of its particles, when it comes into contact with water and a salt, an unstable complex hydrate of the following formula:—(Salt) . $mCaSO_4$. nH_2O. This complex hydrate then gradually decomposes into salt and dihydrate. (P. P. Budnikoff, Zeitschrift fuer anorganische und allgemeine Chemie, volume 155, pages 141ff (year 1926) and Tonindustrie Zeitung, number 57, pages 1009ff (year 1926).

The second process, setting, follows right upon the heels of the first process, hydration. It is, however, impossible to explain the setting process alone by the hydration. The recrystallization phenomenon also plays an important role in this connection. Experiments have shown that the added catalyst separates out during the course of time on the surface of the set mass in the form of a thin film. This undesirable and unattractive "blooming" of the mass is prevented by the use of a combined catalyst, that is from 0.4 to 0.5 per cent of the sodium bisulphate based on the weight of the anhydrite and 0.8 per cent of copper sulphate, also based on the weight of the anhydrite.

The starting material is finely ground natural anhydrite. However, better results can be obtained by using a "dead-burnt" gypsum, that is a gypsum which has been heated within the temperature range of 600 to 700 degrees for a period

of four to five hours. The catalyst, which is used in the experiments, was added either to the dead-burnt gypsum while it was being ground up into an impalpable powder or dissolved in water and then added to the mix while it was being made. The concentration of the solution of the combined catalyst was 8.5 degrees Be. The quantity of water used was commonly maintained at approximately thirty per cent. The fineness of grinding of the dead-burnt gypsum was such that a residue amounting to twenty to twenty-five per cent remained behind on a 4900 mesh per square centimeter screen. Old gypsum products made by the ceramic works could also be used with good results, after the gypsum had been burnt at a temperature of 600 to 700 degrees C. In all cases sand, color, peat, asbestos, iron filings and other substances were added to the anhydrite cement. The anhydrite cement can be combined with magnesite cement. The strength of the pure anhydrite cement (that is without any additions) was attained at the end of twenty-eight days to be 40 to 68 kilograms per square centimeter and it is dependent on the fineness of the grinding, the quantity of water mixed with it, the nature and quantity of catalysts used, the degree of burning, the purity of the raw materials, etc. The temporary strength in tension was 60 kilograms per square centimeter. It is of great importance that no calcium sulphide is formed during the burning of gypsum to produce anhydrite cement, and that the percentage of lime in the substance is not more than 0.2 to 0.3 per cent.

Maintenance Organization Personnel

By S. J. Stewart*

The object is to realize the best results in beneficient accomplishments as to safety, comfort and appearance of our highways with the minimum waste of public money or efforts of men. Colonel Ardant Du Picq states that "Man is an incomparable instrument whose elements—character, energy, sentiments, fears, desires and instincts are stronger than all abstract rules." Since men constitute the personnel of organization, it becomes necessary to use this instrument individually and collectively for the best interest of the object sought.

Since personnel is the foundation and superstructure of all organization, weakness means waste, the result of unstability, which covers most of the sins in public affairs. It seems a good method of procedure to discuss the characteristics of the subordinate head as well as the entire organization.

A man must be healthy, clean and neat and with plenty of energy and sufficient endurance to meet an emergency. Practically all men are honest from a monetary standpoint, but intellectual honesty and a willingness to tell all the truth under any circumstances must be cultivated. The reputation for keeping promises is an asset to the individual and the organization to which he belongs.

The aristocracy of accomplishment is the one class to develop through proper discipline. Pride of accomplishment automatically solves the problem. There must be no intellectual idleness, which is usually the result of servile submission.

The greatest hindrance to progress is fear and a most important work is the development of courage. Sufficient courage should be developed to make decisions and sufficient intelligence to execute them. Trust, confidence and courage are the three simple virtues of business, which are most lacking in governmental organizations. There should be no secrets, no atmosphere of mystery as the aims and ambitions of an organization should be clear to all. Order should be concise and positive, omitting unnecessary phraseology and not nullified by "buts" and "ifs."

Enthusiastic cooperation and harmony must be developed and the zeal of each subdivision to out do the other should not be destroyed. Justice to men is one of the prime essentials of good morale. Discipline, censure and criticism will be accepted if it is just and without favoritism.

General qualifications of supervisors and superintendents are a professional knowledge and skill together with the above related ideals and there must be an intimate and cordial relationship between the maintenance supervisor and his superintendents and conferences should be of short duration, covering the problems at hand and arriving at conclusions.

The public is not interested in the technical details of a proposition, but they do want an improvement in safety, comfort and appearance of the highways. We can continue to improve, if we can inspire our personnel with trust, courage and enthusiasm.

*Abstract of an address before the Fourteenth Annual Conference on Highway Engineering, University of Michigan.

Complete and Up-to-Date

J. D. Hartman, Manager of the Calcium Products Company, Hollidaysburg, Pennsylvania, writes the Editor: "I take pleasure in acknowledging receipt of Pit and Quarry Hand Book for 1928 which I wish to assure you is greatly appreciated. It is hardly necessary to state to you that we find this volume very valuable to us in looking up many things relating and necessary to our industry. You are certainly to be highly congratulated on this complete and up to date issue."

NATIONAL BUILDING INDUSTRIES PROJECT HOME MODERNIZING BUREAU

FINAL organization of a "Home Modernizing Bureau of the National Building Industries," with provisions for a central headquarters in Chicago functioning with a small executive staff and field organization and an initial budget of $100,000 for 1928, will be undertaken at a meeting to be held at the Blackstone Hotel, Chicago, April 11.

This announcement is the outgrowth of the so-called National Home-Building Council, which was tentatively organized in Chicago, March 2. Thirty-one trade associations and other interests, representing as many industries in or allied with the building field, sent delegates to that organization meeting. They endorsed the project for a permanent organization, adopted in principle a constitution and by-laws, and appointed an acting executive committee. The April 11 meeting has been called by this committee. It will be an invitation-affair, which an even larger representation of building interests will be asked to attend.

Walter J. Kohler, president of Kohler Co. of Kohler, Wisconsin, is chairman of the acting executive committee and George E. Piper of Household Magazine, its secretary. As it is now constituted, its other members are: Russell G. Creviston, representing the Plumbing and Heating Industries Bureau; W. H. Hodge, Electrical Industry Sales Conference; Willard E. Maston and William R. McComb, Save-the-Surface Campaign; A. Trieschmann and W. F. Shaw, National Lumber Manufacturers' Association; Oscar W. Rosenthal, National Association of Building Trades Employers and Association General Contractors of America; C. E. Stedman, Celotex Company; Frank A. Hofheins, president, Weatherbest Stained Shingle Co.

During the six-weeks' interim between the two meetings, the groups represented at the first one have had opportunity to consider the proposal for membership in the permanent organization. Every delegate pledged himself to recommend favorable action to his board of directors or other governing body.

Many of the organizations represented at the first meeting have notified the committee that they have taken favorable action on the proposal for membership and have appropriated funds for the Bureau. Inquiries have come from associations and concerns not hitherto represented, asking for a place at future meetings. These requests, of course, are being honored by the executive committee, for the object is to obtain general co-operation among all the interests vitally concerned in the building industry.

Besides changing the proposed name of the organization from National Home-Building Council to the Home Modernizing Bureau of the National Building Industries, and revising the proposed constitution and by-laws in compliance with suggestions made at the preliminary organization meeting, the acting executive committee outlined a program of action. The report states:

"New construction today provides neither adequate nor sufficiently regular and dependable employment for the capital, the manufacturing facilities and the labor-force that constitute the industry.

"After long and careful consideration, leaders in the building field are convinced that a large, substantial and stable market for all types of building materials, equipment and labor can be developed through modernization of the millions of structurally sound, well-located American homes already existing, and that this activity will benefit new construction.

"The whole question now has become one of a practical method of developing that market profitably. While manufacturers, trade associations and similar interests realize the opportunities in this neglected field and are eager to participate in a plan to further their own interests and to support the furtherance of modernization, there must be a central point of control to overcome the usual lost motion, avoid confusion, provide means for co-ordinated activity, and actually to stimulate such work in communities where it is most needed and most susceptible of profitable development.

"The practical details of obtaining this objective include the establishment of a permanent co-operative organization of the entire building industry, which would set up the necessary machinery to develop and maintain in each community a large and uniformly increasing volume of building activity.

"A central office with a small field staff will be established, and an initial budget of $100,000 for 1928 is proposed. The functions of the central office will be directed by the following committees:

"Executive, 11 members.
"Publicity and advertising, 7 members.
"Local campaigns, 7 members.
"Home-financing, 7 members.
"Membership, 7 members.
"Sales co-ordination, 7 members.

"The following activities will be initiated:

"1. A national publicity campaign:

"(b) Direct distribution of press-material;

"(b) Mobilizing the support of newspapers, magazines, banks, civic organ-

izations, women's clubs, public officials, educators and other major influences.

"(c) Supplying press-material, publicity and business building plans to these local agencies.

"2. Local campaigns:

"To devise a standard plan for, and to establish, local bureaus, co-ordinating all local groups and interests.

"3. Sales co-ordination:

"Development of methods and plans in which the sales organizations of the co-operating groups may participate.

"4. Practical co-ordination of advertising and publicity efforts:

"5. Speakers' bureau:

"For national conventions in each industry and other meetings."

This outline of a tentative plan of action, together with the revised proposed constitution of the organization, have been submitted to those invited to the next meeting. Members of the acting committee believe that the project now is in a state of complete preparation for definite action, and contemplate that the new organization will be active within the next few weeks, adding impetus to the nation's impulse to bring its old homes up to date and point out ways by which the various units in the building field may co-ordinate their sales-activities with the movement.

(Continued from page 54)

similar chemicals. This consumption of sodium oleate results from the formation and precipitation of insoluble oleates when calcium salts are present in the water. Water softening may have to be practiced to prevent an excessive consumption of reagents.

The results of two typical tests are tabulated below. Test A was performted on a sample of undersize rejected by the reclaimer screens from one of the washers which treats a matrix containing mainly light-colored phosphate. Test B was made on a similar material from a washer treating matrix in which black grains of phosphate predominate.

TEST A

Product	Weight, per cent	Assay per cent B.P.L.	Insol.	Phosphate recovered, per cent	Insoluble rejected, per cent
Feed	100.0	48.5	37.4	....	....
Concentrate	54.6	75.1	4.3	84.6	....
Tailing (including middlings)	45.4	16.4	77.1	....	93.7

TEST B

Feed	100.0	33.5	54.5	....	....
Concentrate	22.4	71.8	1.9	47.9	....
Middling	22.3	57.7	21.3	38.4	....
Tailing	55.3	8.3	89.2	....	90.5

Middlings from several tests have been re-treated, producing concentrates and tailings with analyses similar to those given in test B. The indicated extraction would then be 85.1 per cent of the phosphate with a rejection of 98 per cent of the insoluble. In several other tests tailings containing from 1.5 to 3.0 per cent B. P. L. and concentrates containing 2 to 4 per cent insoluble were obtained.

In general, concentrates from ores in which the lighter colored grains predominated contained more phosphates for equivalent amounts of insoluble than did the concentrates obtained from ores in which the major portion of the mineral grains were black.

While the results so far obtained in this investigation cannot be applied directly to commercial practice without further research they do indicate that flotation gives promise for the beneficiation of phosphates. Further investigation along similar lines may develop a process which will yield higher recoveries of phosphate rock from the ores now mined, and thus permit profitable operations on leaner deposits, or warrant re-treatment of debris —washer reject—discarded in previous operations. Smaller tonnages of matrix could be mined to maintain a given production program, and reserves of phosphates rock would be depleted less rapidly. The collaboration of Will H. Coghill, acting in an advisory capacity, is hereby acknowledged.

Best Compilation of Reliable Data

C. E. Klaus, superintendent of the Columbia Quarry Company, Columbia, Illinois, writes the following to the Editor upon receipt of the 1928 edition of Pit and Quarry Hand Book: "We think a lot of this publication and believe it is the best compilation of reliable data on our industry available, reflecting great effort on the part of those responsible for its publication and distribution. We feel that it raises the standard of those who take advantage of the information it contains."

Apparent Density of Portland Cement

The apparent density of a powdered material is influenced by the size and form of the measuring apparatus as well as by the manner in which it is introduced. To attain practically useful values, it is necessary to use vessels whose form and size are standardized and the manner of introducing the material generally recognized. The average value of the weight of 100 liters of dry ordinary Portland is 126.6 kilograms, for rapid hardening Portland 120.2 kg. This difference is due to the finer grinding of the latter. Dr. Haegermann (Zement, March 8, 1928).

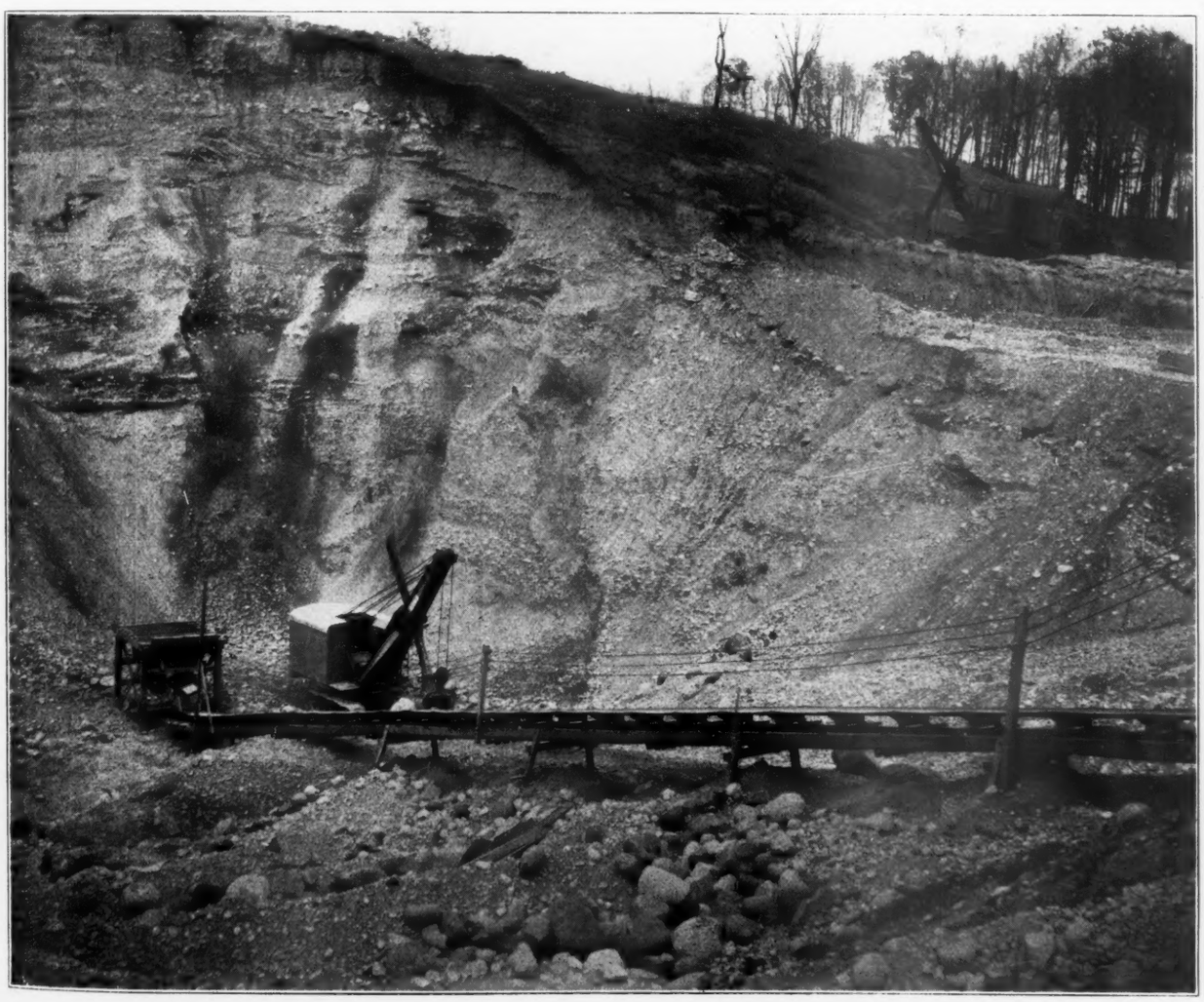
AN EFFICIENT SUBSTANTIAL PLANT PAYS NORTH LAKE SAND AND GRAVEL COMPANY

By E. D. Roberts

ENTERING their second season with additional crushing equipment which will step their production up from 2,000 to 3,000 tons per day, the North Lake Sand and Gravel Company, of North Lake, Wisconsin, feel that the building of their efficient, substantial plant to start with was justified. Money was not wasted in its construction, however. The Telsmith primary crusher, the new Symons cone crusher and the bins were placed on large concrete bases so that they would not rock the plant and cause troublesome shutdowns. Good efficient machinery and equipment was installed so that operating troubles would be at a minimum, all of which has been amply repaid through lower operating costs. There is also another great benefit to be derived from a plant giving the appearance and having a reputation for continued operation—clinching a sale to a large consumer who is concerned about continued deliveries when required.

Close Up of Discharge to Crusher

Mr. L. A. Garrity, the general manager of the North Lake Sand and Gravel Company, designed and built this plant based on his experience of more



View Showing the High Bank

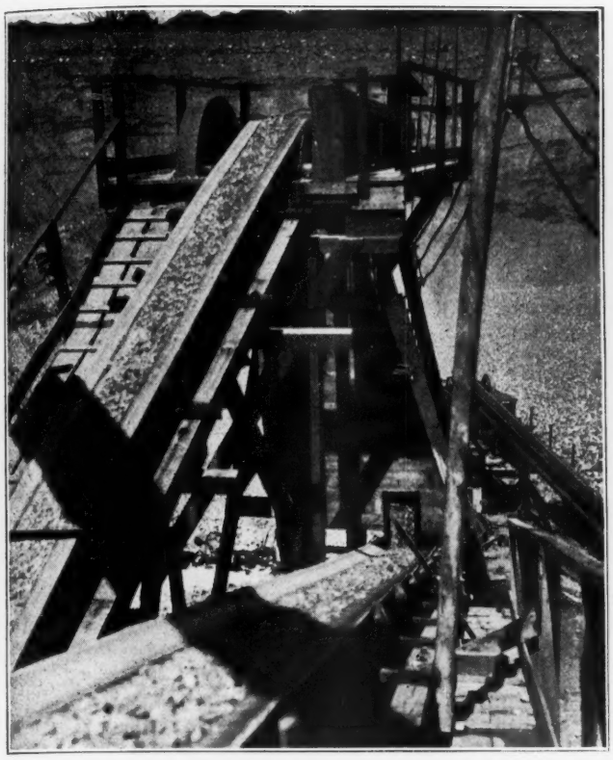
View in Pit Showing Hopper and Belt Conveyor to Plant

than 12 years in the production of gravel in the Milwaukee District where a majority of the deposits carry a large percentage of fine sand which, with the ever increasing desire on the part of inspectors for better aggregates, has become a burden on those plants producing from poor deposits. Mr. Garrity knew that a good bank was essential to efficient operation and that there should be plenty of gravel to secure a better price. To insure having a large percentage of gravel, the deposit should be a hill, for Wisconsin was in the path of the prehistoric glacier which, retreating, left large deposits of gravel of varying sizes depending upon the conditions obtaining at the terminus of the glacier at the time. Some of these deposits were washed down at once while others have been washed over and sorted by the rivers in the time since the glacial era. The hills, however, generally contain an assortment of rock sizes that make excellent concrete gravel when broken by a crusher, enough round pebbles being carried with the broken rock so that the concrete will have a greater mobility and flow easily into the forms. Such a deposit is located on the 173 acres owned by the North Lake Sand and Gravel Company. The hill rises 100 feet above North Lake so that a working face of that height is secured above water level and very little stripping is required. To make the deposit still more attractive, it is located alongside of the main line tracks of the Chicago and Northwestern Railroad.

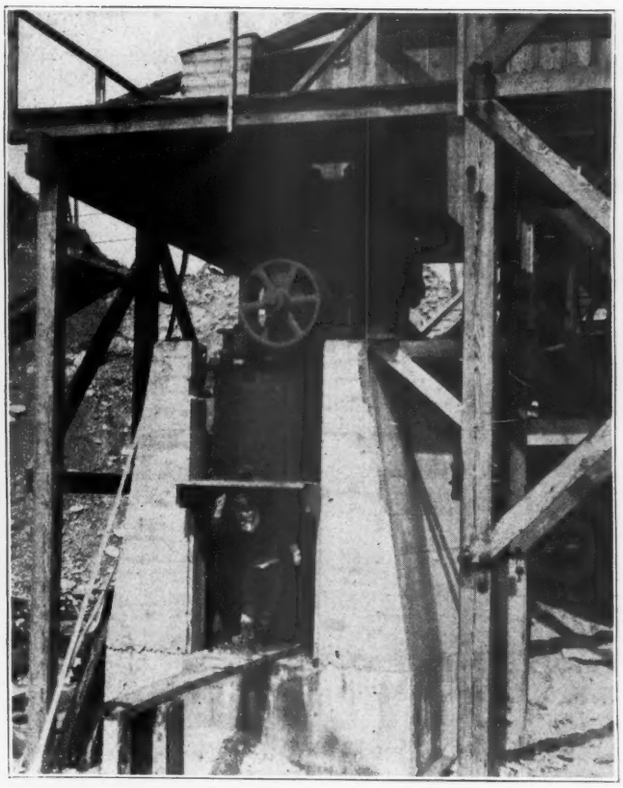
Construction work on the plant was started on March 15 of last year. A ¾ yard type O Thew gasoline shovel was used to remove 30,000 yards of material to make room for 2,000 feet of track and provide a site for the bins, office and crushing plant. The material removed was used to construct a dyke along the Oconomowoc River to provide a settling basin, 18 acres in extent, to take care of the wash water from the plant. Everything was in readiness and the plant began operating in the middle of June. Although designed to produce 2,000 tons on one shift, 2,160 tons per working day was reached many times during last season.

Seventy-five per cent of the bank material is gravel, of which 60 per cent requires crushing to qualify to the maximum allowance of 2 inches in the Milwaukee District. Prior to starting operations this season, the number 13 Telsmith crusher was moved down into the pit to serve as a primary crusher and a Symons 36 inch cone crusher was installed for secondary crushing. This arrangement made possible the increase of the daily production from 2,160 tons to 3,000 tons.

The ¾ yard Thew type O gasoline shovel has been shifted to stripping operations and a new 1¼ yard type 75-A Thew electric shovel has been placed in the pit. The Thew shovel places the bank material in a field hopper, which is of the company's own design and construction having rails on 11 inch centers to reject the large stones. A Telsmith 30 inch by 5 feet automatic plate feeder is attached to the bottom of the hopper to control the rate at which the material is fed to the movable field conveyor belt that carries the raw material to a sloping grizzly at the primary crusher. This grizzly receives the material from the field belt, rejecting stones over 4 inches in size and allowing the finer material to fall into a box leading to the



Showing the Belt Conveyor System



Showing the New Symons Crusher

A Close Up View of the Shovel in the Pit

Looking the Plant from the Northwest

next conveyor belt. The rocks passing through the Telsmith crusher are discharged onto the above mentioned belt and travel with that material to Galland Henning scalping screens.

The Galland Henning rollerless, 60 inch by 12 feet scalping screens allow the sand and gravel smaller than 2 inches to fall through a chute on to a 24 inch belt traveling at 325 feet per minute which discharges its load to the washing and sizing screens on top of the bins. The rocks 2 inches and over are discharged into the Symons cone crusher which, in turn, discharges on to a belt leading back and up along side of the belt from the primary crusher.

After traveling upward at an inclination of 18 degrees for 65 feet, the material is discharged from the belt into a large box which controls the rate at which the rock feeds on to the conveyor belt, joining the raw material from the primary crusher to continue with it through the scalping screen for the second time.

As the material is discharged from the head pulley of the 24 inch belt, 65 feet above the track, it enters a dividing box into which a 4 inch stream of water is jetted. Leaving the dividing box, the material then enters the twin 48 inch by 18 feet Galland Henning rollerless screens, which are equipped with a washing section into the center of which a 4 inch stream of water is sprayed through holes in the pipe. A section of $\frac{7}{8}$ inch

View Showing the Storage Bin and Track Facilities

screen follows with a third section of 1¼ inch screen. Around the outside of the ⅞ inch screen there is a ¼ inch sand jacket to allow the sand and water to fall through into a metal flume which carries this part of the material to two number 8 Telsmith settling tanks producing torpedo sand and discharging the finer material into an 18 inch flume leading to the settling pond. The torpedo sand falls directly from the settling tanks into the large bin below.

Following the ¼ inch sand jacket is a $\frac{7}{16}$ inch screen which produces pea or roofing gravel. The pea gravel falls into a box, the $\frac{7}{16}$ to 1¼ into another box and the 1¼ to 2 inch into a third box. Spouts from these boxes are so arranged that remixing of the materials in any desired proportions can easily be done or the different sizes may pass through to the proper bins below.

Five 18 inch Galland Henning quadrant side bin gates are tapped into the bins on each side at the proper height to load by gravity into railroad cars. The spouts from the gates serving the coarse aggregates have a sieve in the bottom for the first two feet to allow a final cleansing of the rock as it leaves the bin. The cleansing stream is projecting into the gravel in a fan shape at great pressure through a special nozzle.

The main storage bin is divided into four compartments, three 10 by 20 feet each for gravel, and one 20 by 20 feet for sand. A concrete base 24 feet high supports a wooden bin which is another 24 feet high. Ten by 10 inch posts are used in the wooden bin, the girts and braces being 6 by 10 inches. Two inch lumber is used for partitions and sides while the sand bin has an additional 1 inch lining of matched lumber to prevent leakage. Butler batching bins have been installed for use with truck loading which is accomplished by separate gates.

Two American Well Works 6 inch centrifugal pumps, each with a direct driven 60 h.p. motor operating at 1750 r.p.m., furnish wash water for the screens at the rate of 1,000 gallons per minute through independent 8 inch spiral riveted pipes 1,100 feet in length with an actual head of 95 feet. Connections at the screens allow the water from each pump to reach either or both screens.

The two long conveyors are equipped with gravity type take ups of the company's own design. All conveyor belts have a ⅛ inch rubber cover and are of the United States Rubber Company's Security brand. The belt carriers are placed 4 feet 6 inches on centers, while the return rollers are spaced 10 feet apart. These rollers are of the new Galland Henning type, having removable babbitt bushings in the bearings.

Northwestern motors are used throughout the plant with the exception of the drive for the new Symons cone crusher, which is a 60 h.p. Westinghouse motor. Electricity for operation of the plant comes from the Lakeside generating plant of the Milwaukee Electric Railway, Light and Power Company, at 26,000 volts pressure.

The North Lake Sand and Gravel Company maintains their offices in Milwaukee at 288 East

(Continued on page 84)

Close Up of the Screening and Storage Plant

Freight Car Loadings

Revenue freight loading for the week ended March 24 totaled 950,428 cars, the car service division of the American Railway Association announced recently.

Compared with the preceding week this was an increase of 8,342 cars with increases being reported in the loading of all commodities except live stock, coal and coke, which showed slight decreases.

The total for the week of March 24 was a decrease of 54,108 cars below the same week in 1927 and a decrease of 17,517 cars compared with the corresponding week two years ago.

All districts except the northwestern and southwestern reported decreases in the total loading of all commodities as compared with the same week last year while all except the eastern and Allegeny reported increases compared with two years ago.

	1927	1926	1925
September 3	1,117,069	1,143,448	1,102,785
September 10	989,472	1,024,998	975,499
September 17	1,127,613	1,182,641	1,112,009
September 24	1,125,868	1,175,407	1,121,025
October 1	1,126,390	1,180,049	1,113,283
October 8	1,100,552	1,074,928	1,106,036
October 15	1,119,872	1,202,780	1,106,009
October 22	1,128,486	1,200,941	1,120,677
October 29	1,112,621	1,208,878	1,091,154
November 5	1,038,852	1,112,621	1,062,646
November 12	974,862	1,106,889	1,049,940
November 19	968,103	1,071,707	1,057,923
November 26	840,803	937,844	923,206
December 3	918,237	1,054,048	1,023,666
December 10	877,600	992,855	1,008,696
December 17	868,162	944,396	969,738
December 24	829,006	768,940	969,738
December 31	679,600	734,281	701,061
	1928	1927	1926
January 7	754,062	933,940	907,622
January 14	906,734	942,731	931,735
January 21	884,095	936,160	921,643
January 28	902,832	943,879	925,696
February 4	926,204	965,664	914,491
February 11	906,009	962,602	917,625
February 18	887,891	954,794	932,281
February 25	869,590	918,858	912,935
March 3	959,537	989,863	965,009
March 10	951,553	1,000,754	967,425
March 17	942,086	1,001,932	977,018
March 24	950,428	1,003,536	967,945

Complete Reference Book

Charles M. Murdoch, president of the D. S. & L. Co., Ltd., of Shore, Perth, writes as follows: "Please accept our best thanks for the copy of Pit and Quarry Handbook for 1928, which you have so kindly sent us. Apart from being a very fine work of art, it contains much valuable information, and as a complete reference book of classified information will be very useful to us, especially if we contemplate additional new plants."

(Continued from page 83)

Water Street. Chas. J. Petri, Milwaukee, is president; C. E. Randall, Kenosha, Wisconsin, vice-president; C. J. Otjen, Milwaukee, vice-president; August Knoll, Jr., Milwaukee, treasurer; F. W. Knoll, Milwaukee, secretary; and L. A. Garrity, also of Milwaukee, is general manager. E. J. DeLaney is superintendent of the plant at North Lake, Wisconsin.

Future plans of the company include the excavation of the gravel immediately back of the bins so that a track may be laid serving their rear. This extra track will facilitate the shipping of aggregates and provide an outside storage area where a stock pile may be built up during the slack season so that a tonnage larger than the capacity of the plant may be shipped during the summer months.

Many Interesting Facts

Adam L. Beck, President of the Great Lakes Portland Cement Corporation, Buffalo, New York writes as follows of the 1928 Pit and Quarry Hand Book: "It is a very comprehensive book and contains many interesting facts."

Direct Fired Cement Kilns

23.17 kilograms of coal are consumed for 100 kg. of clinker. This coal had a calorific power of 7,143 large calories. The total heat evolved for 100 kg. cement was, therefore, 23.17x7143=165,503 large calories plus the heat evolved of the exothermic reaction 11,400 large calories, or a total of 176,903 large calories. This heat is consumed as follows:

(a) Dissociation of $CaCO_3$ to $CaO + CO_2$	=	49,500 calories
(b) Power	=	63,470 calories
(c) Drying of Raw Materials	=	18,000 calories
(d) Lost Heat	=	45,933 calories
Total		176,903 calories

The efficiency of such a system is, therefore, about 74 per cent, and is 2½ times as great as that of the rotary kiln in its most primitive condition. This effect may be attained only under the following conditions:

1. Utilization of the waste heat of the clinker to the extent of 85 per cent of its heat content.
2. Utilization of the heat of the waste gases for preheating the air for combustion.
3. Utilization of the heat of the waste gases for the production of power.

The clinker cooler should be constructed according to the latest design, such as that of Kunettel, Stehmann or others, making efficient use of the recovery of the waste gas heat for heating the air entering the kiln, in the well-tried manner used by the smelting and metallurgical industries. Not more than 15 per cent of the heat should be lost. Carl Naske (Zement, March 8, 1928).

DUST COLLECTORS IN THE PIT AND QUARRY INDUSTRIES

Part One

By H. W. Munday

DUST is necessarily associated with the manufacture of many products in the pit and quarry industries especially with cement, lime, gypsum and crushed stone. It is in all cases an inconvenience but not always a nuisance. The unisance aspect of dust has been growing in public opinion at a somewhat accelerated rate during the past year or two. Public opinion has been aggressive in a general demand to eliminate preventable conditions. The dust nuisance can be eliminated and the different systems used will be discussed.

While the question of public opinion in relation to dust elimination has been increasing in effect, there has also been some change in the financial aspect of the problem. Markets for the dust recoverable have been expanding. Curtain dusts can be sold for rock dusting coal mines, asphalt filler, filler for mechanical rubber goods, as a carrier for insecticides, etc. Employees are affected probably to a greater extent than previously and certainly as our standards in industry are improved generally prospective employees will have more choice in the surrounding conditions. It is a known fact that mechanics have refused positions offered by pit and quarry plants because of the dust conditions. It is generally recognized that clean wholesome working conditions are conducive to less labor turnover and improved labor efficiency. One financial angle is not generally realized. This is the wear on machinery. A greater quantity of dust proof equipment is being applied today than was the case a few years back. This is particularly true of the cement industry. There still remains much machinery that is affected especially in the lime and crushed stone plants. Belts, chains and bearings are examples. Most of these dusts coming in constant contact with oil become abrasive and wear out machinery before its time. These losses are directly affecting the financial statement.

Much has been said about the physical effects of dust to the workman. In general, the dusts incident to the manufacture of lime, gypsum, cement and crushed stone are not sufficiently destructive to cause any general agitation. These dusts have actually been claimed to be beneficial. However, we shall leave that to others as in our opinion dust is not an agreeable form of medicine. Dust that is siliceous is generally acknowledged to be detrimental to health and dust of this character is not acceptable for dusting coal mines.

There are ways and means of reducing the amount of dust formed and escaping in plants. In general, simplification in the number of units involved will help a great deal. Where a series of crushers are involved with elevators and screens in each step there will be more dust than if say two stages of reduction were involved. Elevators with large buckets moving slowly keep the dust reduced. Dust coming from stone dropping onto storage piles can often be reduced. Adjustable cylindrical spouts can be used. Loading crushed stone into cars through bin gates in the bottom of storage bins is another dust producer. Adjustable spouts will cut down this nuisance. Covers and casings on mills, elevators, conveyors, etc. should be kept tight so that the least possible amount of dust escapes.

If mechanical conditions in a plant are such that dust is made and permitted to escape, the use of some dust collecting system should be considered. Four types of dust collector systems are applicable in the pit and quarry industries. These types can be grouped as follows:

(1) Water Sprays.
(2) Centrifugal.
(3) Electrical Precipitation.
(4) Cloth Filters.

These types as classified here will be discussed separately.

Water Sprays

The water spray type dust collector is used mainly for ventilating purposes or where a small amount of dust is to be taken from a large volume of air. Dust precipitation by this method has not been much used, one reason perhaps being that it returns the collected dust in the form of mud, which cannot be easily disposed of. In a wet process cement plant there would be little call for this type of collector, as there are no rock and clay dryers and raw grinding is done wet. Sprays are finding some application for the precipitation of coal dust because collection of this in the dry condition is always dangerous on account of the chance of spontaneous combustion.

The dust-laden air may be first passed through a cyclone or centrifugal collector in which the major part of the material in suspension is reclaimed in the dry state, so that it may be returned to the process or otherwise profitably used. The air still carrying the finest particles, which cannot be retained by the cyclone, is then passed through a water spray, from which it comes practically colorless.

When the gas is at a fairly high temperature, considerable water will be evaporated in the spray-

ing chamber and will be carried out as vapor into the surrounding air. If the exposure is such that this vapor can condense and freeze on the vent pipe or roof, large masses of ice may be formed, which are likely to become quite troublesome. This should be borne in mind when laying out an installation of this sort.

Centrifugal

The centrifugal type dust collector is at its best efficiency where the dust to be removed is noticeably heavier than air. The principle on which these operate is so old that nearly every one is familiar with it. The collector is made of sheet metal, commonly galvanized steel, and consists of two sections;—the upper, cylindrical or nearly so, mounted vertically on top of an inverted cone which forms the lower section. At the lower end or apex of the cone is a flap valve for allowing accumulated dust to flow out but retaining the air inside the collector, which is usually under slight pressure. The dust-laden air is admitted tangentially to the cylindrical portion. Much of the dust is thrown out of the stream by centrifugal action, and the more or less purified gas leaves the collector through a central opening in the top cover.

This device, commonly called a cyclone, will remove only comparatively coarse particles from the gas stream, and for complete purification its work must be supplemented by that of one of the other types described in this paper. It is commonly followed by a filter or a water spray, and serves a useful purpose in removing a large part of the dust and so lessening the work of the final purifiers. This is of real financial value, for a gas filter is an expensive machine compared to a cyclone designed to pass the same amount of air.

With the cyclone as with the other collectors, the service obtained from the fan depends on its position in the system. If it forces the air into the collector, it will be subject to the abrasion of the dust moving at high velocity and its life may be much shortened. Operators of waste heat boilers are well aware of this fact. On the other hand, if the fan can be placed after the collector, it will handle nothing but clean air and its life should be as long as in other service. In addition, the entire system will be under vacuum and there will be no dust blowing out through leaks.

It is likely that few engineers realize the dimensions to which cyclones are now being built. Several are in successful service, each handling up to 125,000 cubic feet of cement kiln stack gas per minute. Such a unit is 28 feet in diameter and about 50 feet high.

Until recently cyclones could not be used with moist air or gas because of condensation of water inside the shell. This has been overcome by at least one manufacturer. The shell is made double, and into the space so formed, air is blown with a temperature high enough to prevent condensation. With this improvement the cyclone can be used to collect the dust from mills and conveyors in the raw grinding department of a dry process mill. It is well known that air drawn from these sources carries considerable moisture that will condense on cold metal surfaces. It would seem that a steam coil suitably disposed in the jacket space would serve to keep the cyclone warm in the absence of any source of hot air.

Electrical Precipitation

The removal of suspended particles from gases by means of an electrical discharge was first suggested, so far as is known, in 1824 by Hohlfeld, a teacher at Leipzig, Germany. He found that if he electrified a wire hung in a bottle filled with smoke, the smoke cleared rapidly, and a deposit formed on the inside of the bottle. About twenty-five years later this phenomenon was again called to public attention by C. F. Guitard of London, England. Neither of these early investigations led to any practical application of the principle, however, and the subject was apparently forgotten.

Sir Oliver Lodge, of Liverpool, England, again brought up the subject of electrical precipitation in a series of articles appearing from 1884 to 1886. He had independently discovered the same phenomenon as the earlier investigators, and advocated the use of electrical precipitation for the abatement of smoke and the dissipation of fog. The first recorded attempts at commercial application of this principle were conducted at the Dee Bank Lead Works in Wales in 1885 by A. O. Walker and W. M. Hutchings with the cooperation of Sir Oliver Lodge. The apparatus used in these attempts did not prove equal to the requirements of commercial practice, however, and the work was abandoned, although it led to the first patents on electrical precipitation processes in England and other countries. These patents have long since expired.

During the same period, and quite independently, Dr. Karl Moeller of Brackwede, Germany, experimented with the electrical precipitation of dust and fume. While he obtained a patent in Germany in 1884, his method did not prove successful, and no commercial application was made of it.

During the next twenty years an occasional article called attention to the possibilities of electrical precipitation, and a few patents on unimportant details and modifications were issued, but no successful commercial installation resulted.

Dr. F. G. Cottrell, while he was Professor of physical chemistry in the University of California, apparently did the first work of importance in connection with electrical precipitation in the United States. His first experiments were carried out in 1906 and resulted later in the construction of the first successful commercial installation in any country at the Selby Smelting and Lead Company on San Francisco Bay for the collection of sulphuric

acid fumes arising from parting kettles. This plant, very naturally, differed greatly in construction and results from later installations, and much experimental work, lasting over a period of several years, was required to develop the type of highly efficient and ruggedly constructed electrical precipitation installations which have only in the last few years become available to the industries. Based on such developments, numerous patents have been obtained in the United States and other countries, covering what is now known as the Cottrell process of electrical precipitation. This historical summary on electrical precipitation is taken from data published by the Weston Precipitation Company.

The electrical precipitation of suspended particles from gases is accomplished by passing the gases to be cleaned through a high potential unidirectional electrical field, between two oppositely charged electrodes, one of small area, called the "discharge electrode," and the other of larger area, called the "collecting electrode." The collecting electrode is grounded, while the discharge electrode is insulated from it and is connected to a source of high potential unidirectional electricity. During the process of treatment the individual suspended particles are electrically charged, and are driven by the force of the electric field toward the collecting electrode and are deposited thereon. The cleaned gases then pass on through the apparatus unaffected.

The patent rights in the United States are controlled by the Western Precipitation Company of Lo Angeles, and the apparatus has been put to successful use in other large scale manufacturing operations, particular instances being the coagulation of sulphuric acid mist and the clarifying of smelter smoke containing arsenic trioxide and other solid ingredients that are either valuable in themselves or are injurious to the surrounding country when turned into the air.

When properly installed and operated the Cottrell precipitator is said to collect better than 95 per cent of the dust entering it. It may be so constructed as to stand up under exposure to many corrosive gases and vapors, and will handle gas at a temperature up to 450 or 500 degrees C.

Its principal application in the pit and quarry industries has been in connection with the collection of dust and potash from cement kiln stack gases. A number of installations for this purpose were made during the war under the incentive of the high price for potash, but since this has come down to a reasonable figure, the collection of potash from the kiln gas is not in all cases attractive.

The Cottrell system will also handle any of the other dusts evolved in cement making or in other pit and quarry products, with the exception of coal dust. It has not come into extensive use, however, apparently because of its initial cost and the electrical hazards involved. It is understood that its sponsors will not recommend its use on coal dust or any other flammable dust because of the danger of initiating an explosion.

In part two of this article we shall discuss further operation of the electrical precipitation type of dust collector and also the principles and designs of the cloth filter type dust collector. We shall present some diagrams and data on actual dust collecting installations in the field.

Utilization of Greensand

Various attempts have been made to utilize greensand for the production of potash, and most of them have met with failure. Many processes have been invented for the extraction of the potash, and while successful operation has been attained on a laboratory scale commercial operation is more difficult. Because of the low percentage of potash present in greensand (6 to 7 per cent) it is probable that successful utilization can be accomplished only where by-products can be profitably marketed. The two outstanding processes are treatment with milk of lime, and acid leaching. A survey has been undertaken by the Bureau of Mines to determine the quality and quantity of by-products resulting from treatment by these methods, the cost of production, market demands for the by-products, prices to be expected, and freight rates to points of consumption. The object is to determine if the actual profit that may be expected from by-products will be of sufficient magnitude to make potash extraction commercially successful. If this survey indicates probable success along any particular line it will be followed by laboratory research.

The Highway Engineer's Creed

Public Roads published a highway engineer's creed as follows:

"Believe that transportation is the keynote of the structure of civilization which is built of school, and church, and court, and market place upon the twin foundations of the home and productive industry.

"Believe that highway transportation is a necessary and integral part of this connecting stone in civilization's arch and is coequal with other forms of transportation in sustaining the body of the structure.

"Believe that my mission, as a highway engineer, is to assist in shaping and improving the highways of my country, in harmony with those who provide the vehicles which are their necessary complement, to the end that, joined with other means of transportation, they may meet the need of our people for easy, quick and untrammelled transportation."

VARIATION IN ADSORPTION OF ASPHALT BY DIFFERENT MINERAL AGGREGATES

By A. W. Dow*

LAST year in a paper read by me before the American Society for Municipal Improvements I showed that it had been known for many years that sands having the same mesh composition and the same percentage of voids varied greatly in the amount of asphalt cement necessary to make a satisfactory paving mixture and that this was evidently due to variations in the adsorption properties of the mineral aggregates. Mr. Victor Nicholson also read a paper at the Fifth Annual Asphalt Paving Conference in which he showed a great difference in the stability of asphalt mixtures made with different sands but with the same quantity of asphalt cement in each case. In his final conclusions he attributed these differences in stability to sharpness in the sand grains and irregularities in their surface. I believe that the differences in stability were too great to be entirely accounted for by physical differences in the shape of the grain alone but that they were largely due to the difference in the adsorbent character of the sand grains.

It is my purpose to endeavor to explain why different mineral aggregates vary in their adsorptive properties and to see if it is not possible to account in this way for the differences noted by Mr. Victor Nicholson and myself.

As I find it more convenient in this paper to use terms that are not defined in many dictionaries but that are in use by colloidal chemists I will try to make clear their meaning.

Adsorption is a term that had generally been accepted to denote the surface attraction or adhesion of one body for another as for example, when a powder adheres to the surface of a solid; when a liquid wets a solid or spreads out over the surface of any other liquid; or when a gas or vapor condenses on the surface of a solid. H. M. Holmes in his Laboratory Manual on Colloidal Chemistry, page 68, express this very clearly. "It seems that every solid surface has an attraction for other substances, greater for some than for others. This holding to a surface we call adsorption and we differentiate it from chemical reaction or solid solution. It may be due to free valance of the surface atoms but whatever it is we are able to measure it and study it. Some solids have far greater adsorbing power than others and a given adsorbent shows preferential adsorption. Of course the finer a solid is the greater its surface area and the greater its adsorbing effect per gram."

Sol. A sol is the material that is in suspension in a colloidal solution. When a sol is coagulated or precipitated it forms what is known as a gel.

Gels. are highly absorbent gelatinous bodies which result from the coagulation of sols.

Emil Hatschek in his book "An Introduction to the Physics and Chemistry of Colloids" says:

"One other property of colloids, which shows itself particularly strikingly in their 'gels' is their capacity for taking dissolved substances out of solution and retaining them often with very great tenacity. This phenomenon, which is the greatest importance in nature and in many industries, is now generally called "Adsorption."

The mineral aggregate which I propose to give most attention to in this discussion is sand because sands from different localities show variations in the quantity of asphalt cement they will carry which cannot be entirely accounted for by either the void or surface area theory. I believe that this variation is due to the surface condition of the sand grains themselves not in the sense that some grains are visibly more rough than others but that sand grains of different composition vary in their natural adsorption for asphalt and besides sand grains as found naturally are coated with more or less adsorbent films in many cases even invisible under a microscope. These films are gels that have resulted from the coagulation of colloidal sols. Their adsorptive properties would naturally vary greatly depending on their age, under what conditions they were deposited and as to what conditions the sand has been subjected since the deposition of the gel; as for instance they may have been more or less destroyed by erosion resulting from the sand having been washed about by water or blown about like Dune sand. The colloidal solutions which deposit those gels are constantly present in nature as the result of the decomposition of various rocks as for example when feldspar, one of the most common mineral constituents of granite as well as other rocks, is decomposed it forms alumina silicate which is highly colloidal and adsorbent but insoluble in water and alkaline silicates which readily go into colloidal solutions in water and which when precipitated form a highly adsorbent gel. In the decomposition of minerals containing iron, the iron often goes into colloidal solution and is deposited in the form of a reddish yellow gel. It is this film that is so often seen on sand grains. It has been our experience that sands containing this reddish film requires more asphalt than usual.

There are innumerable instances in geology

*Paper presented at the Sixth Annual Asphalt Paving Conference, Atlanta, Ga., November 28-December 2, 1927.

which show the depositing of these gels on other mineral particles. It is by this process of gel deposition that sandstones are formed in nature; for example a colloidal solution of silica seeping through a deposit of sand, silica acid is precipitated as a gelatinous film on the surface of the grains and as this film hardens it cements the individual grains together.

From the foregoing it is evident that a great difference in the surface adsorption of different sand grains is to be expected.

Bulletins of the Bureau of Soils during the last 25 years have shown differences in the adsorbent properties of various soils and powdered minerals Their tests, however, have been confined to more minutely divided particles than sand grains and their tests have been confiined to ascertain the adsorption by these mineral powders of dyes and salts from water solutions.

The Bureau of Soils found that quartz powder ground for several days in a ball mill to a fineness of between 1 to 50 microns showed not appreciable adsorption of malachite green. They also show by other work that the amount of dyes absorbed by colloidal earths varied depending on the composition of the dye.

I have found that an appreciable quantity of asphalt is adsorbed from a carbon bisulphide solution by quartz grains (50 to 200 mesh) far coarser in size than the powdered quartz used by the Bureau of Soils. It is therefore very evident that the amount of dye adsorbed from a water solution would not indicate the adsorptive value of mineral aggregates for asphalt. We therefore use as a basis of our test the adsorption of asphalt cement from a bisulphide solution. This seems to be more closely in accord with the actual conditions and our results show in the examination of fillers and sands that there is a relation between the amount of asphalt adsorbed and the quantity necessary for the mineral aggregate examined, and we have therefore adopted this test for the examination of fillers and sands.

Our method for determining the relative adsorption of asphalt by sand grains is different from that described last year by the writer for the examination of finely divided materials such as clays, earths, fillers, etc., because the latter are so highly adsorbent when compared with comparatively coarse material composed largely of crystaline quartz. The method for sand is as follows:

The sand is first screened on a 200 mesh sieve and while screening it is brushed around the surface of the sieve so as to free as much as possible the fine mineral particles that adhere to the coarse grains.

After a thorough screening on the 200 mesh sieve all material coarser than 50 mesh is screened out. In this way we obtain a sand composed of 50, 80 and 100 mesh particles. 27cc of the sand is then poured into a tube making a column 50 centimeters in height, through this is poured a 0.5 per cent solution of asphalt cement dissolved in carbon disulphide. The first 10cc that seeps through the sand is caught and compared with a color scale. This scale is an arbitrary one, zero being the color of the .50 per cent original solution of the asphalt in disulphide and 10 being colorless. Therefore 5 on the scale would be the color of the original asphalt solution diluted one-half, etc. You will find in the accompanying table tests made by this method on pulverized quartz, pulverized feldspar, pulverized granite and sand obtained by extraction from Kentucky rock.

Adsorption of Asphalt Cement from 50 Per Cent Solution in Carbon Disulphide by Various Mineral Aggregates.

Asphalt Cement used, straight run Mexican oil 50 penetration, mineral aggregate all passing 50 mesh and retained on 200 mesh.

Materials examined	*Adsorptive Value*
Granite	7.0%
Feldspar	6.5%
Kentucky Rock	9.5%
Quartz	3.5%

The crushed granite was a commercial grade and while much of it had not been exposed to the weather yet it had undergone sufficient exposure to have caused partial decomposition of some of the mineral ingredients especially the Feldspar, which on the slightest grinding with nothing more than moisture present starts to decompose into alkaline silicate and alumina silicate both of which produce highly adsorbent gels.

The Kentucky Rock Asphalt sand is very interesting in that it is a soft white sandstone. It crumbles easily in the fingers, in fact the silicious cement in the sandstone is so weak that part of the rock falls to sand on extracting the bitumen. Very likely it was in the formative stage from loose sand into sandstone when an oil seeped into it and hardened in its pores. Being in the formative stage, it must have had considerable active silica gel deposited on the grains. The oil coating on the grains evidently protected the gel from influences that would lessen its adsorptive properties. Without thinking we at first tried to determine the adsorption on the sand after extracting with carbon disulphide and were surprised to find it nil. This is readily explained when you consider that the sand had only been extracted with carbon disulphide and that it still contained the adsorbed asphalt which can not be washed out with carbon disulphide. It was for this reason that we were obliged to burn out the adsorbed asphalt.

The quartz sand was obtained by crushing massive quartz to the required mesh composition. This quartz sand had never been exposed to the weather or salt solutions in the soil and therefore was prac-

tically free from any gel films on its surface. The adsorption of the asphalt by the quartz is therefore merely the natural adsorbent value in the quartz itself.

Before proceeding further with the subject it is well to consider what effect variations in the adsorption of the mineral aggregate will have on asphalt paving mixtures. The mixture with the mineral aggregate having the highest adsorptive power, everything else being the same should hold the most asphalt cement.

If two paving mixtures alike in every way as to composition, voids, etc., are tested for stability the one containing the mineral aggregate with the highest adsorptive value will show the highest stability.

In Mr. Nicholson's results therefore where the mixtures were all made with like percentages of Asphalt Cement and filler the difference in stability would be largely due to the adsorptive value of the mineral aggregate. Of course the mechanical bond resulting from the interlocking of the sharp grains would have more or less influence on the stability of the mixture. The sharper and rougher the grains, naturally the greater the stability of the mixture. If this theory is correct what results should be expected from Mr. Nicholson's four mixtures, Lake sand, crushed quartz, crushed granite and Kentucky Rock sand. In commenting on the characteristics of these sands he says: "Examining these grains under a microscope we find that the Lake sand is sharp in sizes smaller than sixty mesh but as the sizes get larger the sand becomes more round. Quartz and granite are sharp and angular in all sizes. Kentucky Rock aggregate is sharp and angular in practically all sizes down to 40 mesh when it seems to show some evidence of water wear" and further on he says "Considering all these materials, crushed granite gives the highest stability result, but on examining the grains under a microscope crushed quartz is the most angular. In carrying our examination still a little further we find that granite has a very rough and pitted surface. While the crushed quartz particles are sharp they have a surface of a more glassy nature."

Discussing Mr. Nicholson's results, it appears probable that a lake sand being continuously shifted by disturbances in the water has had all its gel films worn off the grains by attrition and therefore would have a low absorptive value. The crushed quartz grains would also be low in adsorption because of the absence of any gel formation but we would expect a higher adsorption than sand because of the roughness of the grains and the mechanical bond resulting from the angular shape. The crushed quartz that he examined were likely a commercial grade of screenings from quarry crushing considerable of which was more or less weathered and would naturally be expected to be rich in gels. The crushed granite and Kentucky Rock sand as before explained would be high in adsorptive value and therefore show a high stability in the paving mixture.

Speculating on the results obtained from pat paper tests, as given by myself in my paper read before the American Society for Municipal Improvements.

The four aggregates spoken of, Nutley Hall, Lake Erie sand and crushed quartz; the Nutley Hall sand was from a deposit in a quiet bay down the Potomac from Washington, D. C., where the river is very wide. There could not be sufficient motion to the water to disturb these sand grains and thus erode to any extent films that had been deposited on their surface. The sand grains were rather rounded.

The Lake Erie sand was from Sandusky Bay and from its glazed appearance it must have been in water that was considerably disturbed at times. I am told that the storms on Lake Erie produce undertows that would result in considerable motion of the sand on the bottom of the lake near the shore. This would therefore make it somewhat water worn and would have destroyed most of the films that had been deposited on it.

Judging from the mechanical appearance of the Nutley Hall sand and the Lake Erie sand I would not expect much difference in the mechanical bond, that is a bond resulting from the interlocking of sharp grains, one with another therefore any difference in the amount of asphalt which one would hold over the other must be dependent on some other factor.

The crushed quartz are naturally very angular and sharp with fairly rough surfaces. It would be expected that this sand would hold considerable bitumen if the quantity were only dependent on the mechanical character of the sand grains.

In comparing the results of the pat tests we find that the Nutley Hall sand carried the most asphalt. The crushed quartz next and the Lake Erie sand next. This would also rather substantiate the adsorption theory.

The two sands in the United States which I have found hold more asphalt than any others are from Denver, Colorado, and Boston, Mass. Both of these contain decomposed granite grains. The Denver sand holds 14 per cent of asphalt and the Boston sand 12.5 per cent. It is natural to expect therefore that colloidal gels in these decomposing granite grains would produce a high adsorption.

While I am a great believer in high asphalt cement in paving mixtures it is not always safe to use such mixtures because this high percentage may be due to the presence of granites that are still undergoing decomposition. The Denver sand mentioned above holding 14 per cent of asphalt was very poor and the pavements rapidly rotted.

PIT & QUARRY FOREIGN DIGEST

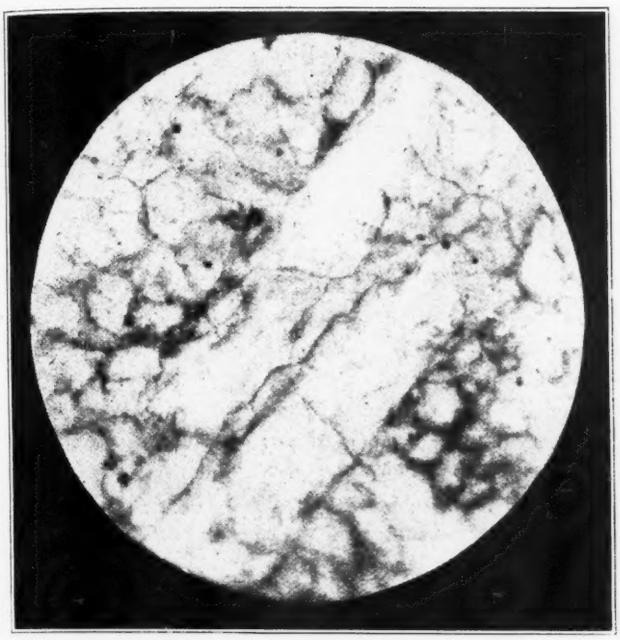


Figure I

Crystal Structure of Portland Cement

Jaenecke, in reply to Guttmann and Gille's statement that both Dyckerhoff's dicalcium-silicate and J's Alite are varieties of mixed crystals, points out that if this were really so, all mixtures between 3 CaO. Al_2O_3 must be homologous. The biaxial crystalline tricalcium silicate must so completely overbalance the presence of one-third of its weight of the regular tricalcium aluminate, that the optical properties of the latter are completely "swallowed up" and are indiscernible as even a variation of tricalcium silicate. J. considers this impossible. He points out that mixed crystals would show variations in melting point, specific gravity and other properties, the optical characteristics fluctuate with the composition. Alite does not exhibit these variations and therefore is the compound 8 CaO. $2SiO_2$. Al_2O_3, the main constituent of Portland cement. (Zement, January 12, 1928).

On the other hand Guttmann and Gille reply that they have demonstrated that tricalcium silicate is capable of absorbing more or less alumina, depending upon its conditions of formation. This absorption may be as great as 15 per cent. The possible cause for confusion lies in the fact that tricalcium silicate and tricalcium aluminate have distinctly different but very similar optical characters. The aluminate is said to be pseudo regular and not regular, and the silicate rhombic, with constants almost within experimental error. The double refractivities are both very small. Zonal regions within the crystals are visible only with crossed Nicols. Figure 1 shows a section of fused cement clinker with ordinary light and Figure II the same section under crossed Nicols. The zonal regions are clearly visible in the latter. Guttmann and Gille, for these and other reasons retain their belief that Alite is a substance composed of mixed crystals. (Zement, February 23, 1928).

Plaster of Paris

The course of the setting of plaster of Paris was followed by observing the electrical conductivity of the solution which forms in the immediate vicinity of the plaster, and also by measurement of the heat change. Anhydrous calcium sulphate prepared below 300 degrees is transformed immediately on contact with water into the semi-hydrate, forming a saturated solution which is supersaturated with respect to gypsum the difference between the solubilities of the semi-hydrate and of gypsum being greater at the lower temperature. After a time gypsum crystallizes out and heat is evolved; this corresponds with the commencement of the setting. If the anhydrous calcium sulphate is prepared above 300 degrees C., a different form is produced which rehydrates very slowly, the time increasing with the rise of temperature of preparation. A saturated solution of $CaSO_4$. $\frac{1}{2}H_2O$ at 16 degrees does not crystallize for 15-28 minutes if care is taken to avoid inoculation, but if nuclei of gypsum are present in the original material the velocity of setting is increased. Setting is accelerated also by the presence of salts which increase the SO_4-i on concentration, and by acids which do not cause a precipitate. Poor plaster work is generally due to an excess of water for setting; with increasing amounts of added water the apparent density and compressive strength of the plaster decrease. M. L. Chassevent (Bull. soc. d'encour. 125, 789-803 and B. C. A.).

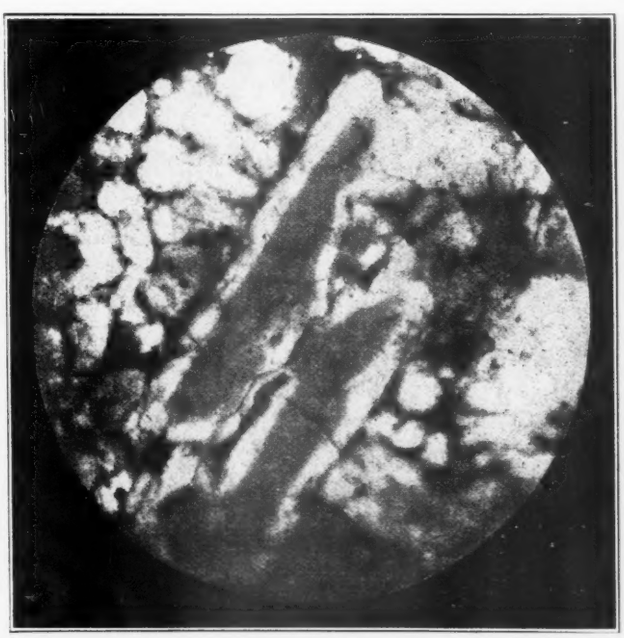


Figure II

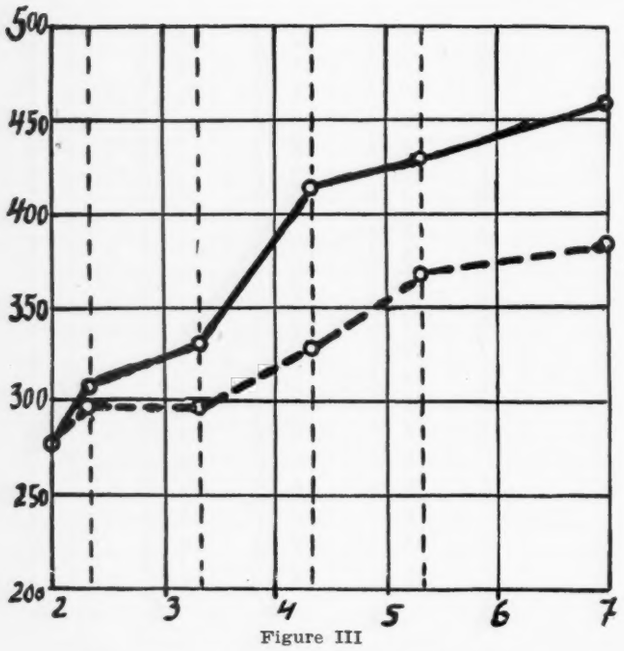


Figure III

Frost on High Quality Cement

The influence of frost upon the retardation of the hardening is shown in Figure III, the solid line showing the compressive strength in kg. per sq. cm. attained up to 7 days without frost and the broken line the strengths of a similar cement mixture under frost conditions. Figure IV shows the effect of curing in the cold, just above freezing and at ordinary temperatures. The solid line shows the rate of hardening of cements kept at 15 to 20 degrees, the broken line at 0 to 5 degrees C. The author concludes that high quality shows a similar effect to ordinary Portland when cured in high or low temperature, but its strength values are nevertheless greater than for ordinary Portland under the same conditions and the use of high quality (rapid hardening) is to be recommended in any event. A. Gessner (Zement, January 5, 1928).

Calcium Hydrosilicates

It was desired to produce calcium silicates similar to the well-defined sodium silicates. Molecular ratios of $CaO : SiO_2$ of 1 : 2, 1 : 1 and 2 : 1 showed that the metasilicate the second, was the most stable, although like all hydrosilicates, is subject to hydrolysis. In contrast with this compound, the expected disilicate did not seem to exist, the tendency to combine with lime being too great. On the other hand, the silicate rich in lime, the calcium orthohydrosilicate showed a strong tendency to split out lime, so that a normal orthohydrosilicate was not obtained. The naturally occuring hydrosilicates are mostly meta or ortho compounds. Plombièrite according to its fromula $CaSiO_3$. $2 H_2O$ is a meta silicate and a natural cement, as it forms a gelatinous mass with water which hardens in the air. Other natural hydrated silicates are: Fonotlite, 4 $CaSiO_3$. H_2O, Hillebrandite, unstable to water, an orthohydrosilicate of the composition 2 CaO. SiO_2. H_2O. Okenite occurs in distinctly rhombic crystals as CaO. 2 SiO_2. 2 H_2O. F. Klasse (Zement, January 12, 1928).

Alabstrite and Alum Plaster

Gypsum alabaster (or alabastrite) is found set between two masses of dolomitic marl. The chemical composition of Vallières alabaster is 98-99 per cent $CaSO_4$. 2 H_2O; it is a pure, crystalline sulphate of lime, mixed with traces of celestine. The utilization of Vallières alabaster for plaster dates only from the last century. The first factory consisted of a coffee mill of exaggerated size situated on the River Marne. Alum plaster or white cement, English cement, consists of pure alabastrite dehydrated to ½ H_2O and treated with alum. This makes the plaster more soluble in water, as it seems to cause the formation of crystals of very small size. Alum plaster does not occupy among construction materials the place which is its right as it is especially suitable for stucco. It may be used with a minimum of pure water, about 23-27 per cent. It is easy to wash and does not generate heat in setting. It has a crushing strength of 35 to 40 kg. per sq. cm. and a tensile strength of 35 to 40 kg. The time of setting may be regulated either slow or fast. It may be used to imitate natural rocks. These imitations look new for a long time due to the presence of the alum. E. Taté (Le Ciment, February, 1928).

Protecting Concrete

The following conditions for protective coatings have been established: 1. After application no cracks must develope, and this must also be true even after the lapse of time. In other words sufficient elasticity must be possessed by the coating to follow volume changes of the concrete mass. 2. The influence of air, moisture, salts and dilute acids must have no effect upon the surface coat nor must it be affected by hydrogen sulphide or sulphurous acid.

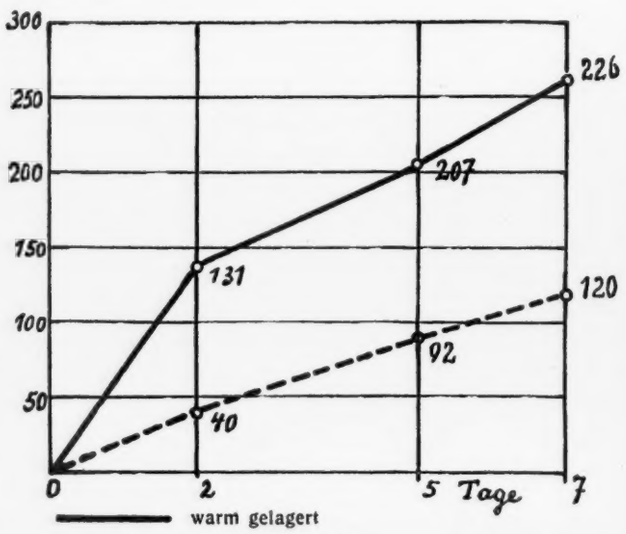


Figure IV

INTIMATE NEWS OF MEN AND PLANTS

Wood Brothers Purchase Golconda Quarry

The Wood Brothers Construction Company of Kansas City, Missouri, recently purchased the lease on a rock quarry on the river south of Golconda, Illinois. The quarry was originally opened by the Sand and Gravel Company of Evansville, Indiana, in 1926 and later the equipment was transferred to John Kline of Cairo, who sold his interest to Wood Brothers. The construction company which operates large fleets of steamboats and barges, has contracts to supply material for construction on the Mississippi River.

Kaiser Plant Begins

The $200,000 rock plant of the Kaiser Bechtel Company has recently started operations on the Oroville-Marysville Road, near Oroville, California. The plant was constructed in 40 days, after starting development, to handle the rock left by gold dredges, which formerly operated along the east bank of the Feather River.

Concrete Products Plant For North Dakota

The North Dakota Concrete Products Company has started the erection of a plant on the site of the Minot Colliery, a short distance west of Minot, North Dakota. "Cretex" will be the trade name of the product which will consist of culverts, sewer and drain tile pipe. The company operates at Mandan, North Dakota; Crookston, Minnesota; and Helena, Montana.

New Sand and Gravel Pit For Beine, Indiana

The Affolder Brothers, who recently leased the sand and gravel deposit on the Charles Sullivan farm have started operations. A new six inch sand pump has been purchased which is being operated by 36 Rumely oil pull tractor. The product will be washed and sized as soon as the necessary equipment is installed.

Garlinghouse Purchases Quarry

The Garlinghouse Brothers, monument builders of Lewiston, Washington, have purchased a quarry from the Idaho Granite Company. The quarry is located at the mouth of Corral Creek about 50 miles up the proposed Snake River Railroad over which the product will be shipped.

Triangle to Mine Clay

The extensive clay deposits near the mouth of Roche Canyon, which are owned by Colton Portland Cement Company are to be mined by the Triangle Rock and Gravel Company of San Bernardino, California. The clay will be used in the manufacture of cement at the Colton plant and will require two power shovels and eight trucks.

New Plant for Iowa

The recently incorporated Iowa Lime Rock Corporation of Oskaloosa, Iowa, will open a quarry and erect a crushing plant near Tracy. A spur is being put in and as soon as it is completed and the machinery installed, the plant will start producing rock for construction and agricultural lime.

New Indiana Stone Mill

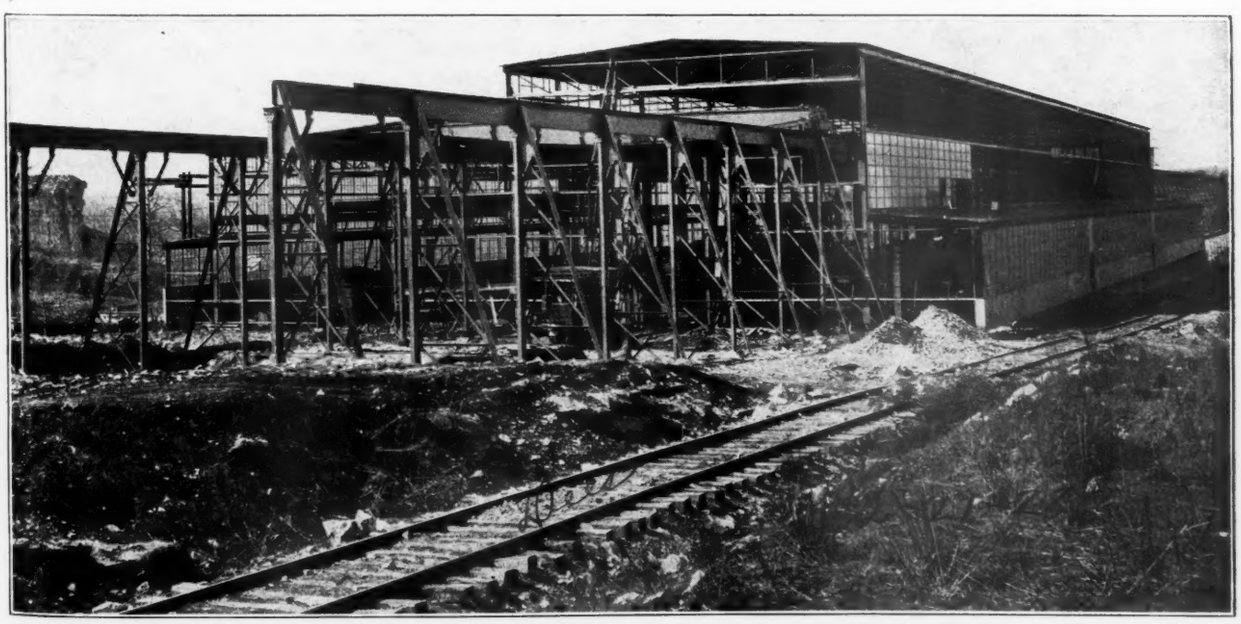
Construction has been started to erect a $100,000 stone mill for the Sare Stone Company of Bloomington, Indiana. The quarry is located a mile west of Smithville on land owned by T. J. Sare, John W. Hoadly and Albert Hoadly.

Now West Michigan Sand

Articles of Association of the West Michigan Sand, now operating under the name of the West Michigan Sand and Fuel Company, have been filed in Muskegon, Michigan. Max B. McGill of Cleveland is president of the new company with whom are associated other Cleveland interests.

Houghland Promotes Freshley

Sam Freshley of Rockport, Indiana, who has been superintendent of the plant for the Houghland and Hardy Sand Company of Evansville has been promoted to general superintendent of production. The company has operations at Rockport, Patoka, Sandals and Terre Haute.



Steel Biulding Being Completed for the Rockwood Alabama Stone Company. The Ingalls Iron Works Furnished and Erected Steel Frame Work, Steel Sash, Roofing, Siding and Doors. The F. R. Patch Company Installed Machinery and Foundations.

A Wood Brothers Experience

Three years ago, the Wood Brothers Construction Company, of Kansas City, took a contract to fill in a tract along the Missouri River, part of a levee undertaking, with material dredged from the river bed. The field conditions, a maximum lift of 25 feet with a maximum length of 12 inch pipe line of 1100 to 1200 feet, indicated the type and size of pump and a 12 inch Amsco centrifugal pump was purchased.

At the completion of the project, the company determined to utilize the dredging equipment for commercial production of sand and erected a tipple for handling, screening and loading of the product to cars.

The lift was increased to between 55 and 60 feet and the pipe line had to be extended, resulting finally in such a reduction of output that a revision of plan was necessary. The pump and driving motor had been selected for conditions of head so different from those now encountered that it appeared wise to pump from the river to a sump and to relay the sand to the tipple by means of an Amsco 10 inch centrifugal.

This permitted reducing the head on the original pump to that on which it could show satisfactory economy and output; allowing for the wasting of fines from the sump rather than from the tipple whose capacity was such as to give more efficient operation on a reduced pumpage; and effecting an economy in power due to lifting the initial water only to the level of the sump and a much smaller volume to the tipple.

This procedure was sound also because the dredging operation is of the foraging type, the materials being brought down by river current and deposited with debris in uncertain amounts, with much variation in the content of commercial sizes. This made it economic to dispose of all debris and fines of widely varying amounts by fluming, or at times by pumping, to waste from the sump, rather than to attempt to effect separation at the tipple.

As drawn from the river bed, the sand has approximately the following analysis:

Passing	100 mesh screen.....	3.4%
Passing	48 mesh screen.....	13.8%
Passing	28 mesh screen.....	30.0%
Passing	14 mesh screen.....	28.3%
Passing	8 mesh screen.....	15.3%
Passing	4 mesh screen.....	7.7%
	⅜ inch mesh.....	1.5%

About 15 per cent of the dry sand produced is combustible organic matter, mostly lignite.

The hull of the number 4 dredge is 24 feet wide, 5 feet deep and 100 feet long. A fifty foot suction line is available, and the dredge can work to a maximum depth of about 42 feet although the average at present is about 35 feet below the water level.

The 12 inch Type H Amsco Pump is belt driven from a 250 h.p. 3 phase variable speed induction motor which receives power at 440 volts from a transformer substation on the shore. The driving and driven pulleys are 26 inches and 32 inches in diameter, respectively, and the pump is driven at about 470 r.p.m. at a motor speed, under full load, of 580 r.p.m. The pump is of right-hand bottom discharge design.

The 12 inch discharge line is carried ashore on a series of pontoons and has an average total length of 860 feet from the dredge to the sump into which it discharges. The average total height from the river bottom to the center of the discharge opening is approximately 51 feet and the lift is about 16 feet.

The sump is of concrete, 6 feet wide, 30 feet long and 7 feet deep. A wooden flume is provided at the shore end to carry off excess water and sand too fine for use, this latter discharge amounting to about 50 per cent of all sand taken up.

A 10 inch type H Amsco pump relays the sand from the sump to the tipple through 180 feet of 10 inch pipe, elevating it approximately 40 feet above the level in the sump. This pump is direct-connected to a 150 h.p. three phase induction motor operated at 435 r.p.m. on 440 volt power.

The tipple is mounted on a gantry framework between the legs of which is laid a standard gauge shipping out track. Screens and drains are provided in the tipple for the draining of the sand and for the separation of regular commercials and from the extra coarse grade which makes up about ⅛ of the total production.

The sand is loaded into gondola cars spotted on the shipping out track, but can be chuted to a storage pile parallel to the gantry run-way. Average production during the working season is scheduled so that a reserve of about 100,000 tons can be built up. Shipments can therefore be made regularly regardless of the season, a steam operated clam shell being available for loading out at times when the pumps are not in operation.

The sand plant is in regular operation for about eight months from the latter part of March until the early part of December each year. Except for shut-downs necessitated in shifting the equipment the operation is practically continuous, 10 hours a day for seven days a week. A night crew was employed during part of the past season because the dredge had progressed to such a distance from the sump that production in a single shift became inadequate to meet the demand for sand.

Peak production of 1,100 tons of commercial sand in ten hours of pumping was reached on several occasions during one season. The average is considerably less and the records for the last two months of the season show an average output of 575 tons in an average of approximately 6 hours of pumping. Eliminating that which is flumed to waste as fines, the average pumpage to the sum is approximately 1,150 tons or, roughly, at a rate of 190 tons per hour of actual pump operation.

The routine maintenance of the 12 inch pump is comparatively simple. Oiling is in charge of one man who attends to all dredge equipment. Fifteen minutes of his time daily is an ample allowance for oiling and inspection. The consumption of machine oil is about six gallons per season. Repacking is required twice a week on the 12 inch pump as this unit is not equipped with high pressure water connections at the glands to exclude sand. This requires not more than 1½ hours of labor a week and 28 pounds of packing is used in the average season. The ten inch pump glands are supplied with high pressure water, increasing the life of packing about 8 times, as compared with the 12 inch unit.

Depreciation and average interest at 6 per cent have been calculated on the basis of a 10 year life for the unit as a whole. The cost of replacement parts, including shell, liners, shaft and impeller, is calculated on the basis of their respective wearing lives. The annual repair and replacement labor allowance of $170.00 is ample to cover both the field work on the pump and machine work involved in the maintenance of shafts.

The total annual fixed cost of $1,275.95 is distributed over 215 days of actual operation during a season, giving a daily fixed cost of $5.93. To this are added costs of packing, oil, maintenance labor and power. The latter charge is the largest single item and has been determined from meter readings made on the motor during average operating conditions and for six hours of actual operation. Including all items, the daily cost for six hours of actual pumping is $35.61. For the average daily production of 575 tons of sand, the unit pumping cost, exclusive of overhead charges, is $.062 a ton.

Ohio Lime and Stone Company Features Artint

About three and one-half years ago a lime company was formed, which chose as its name, The Ohio Lime and Stone Company. Immediately after its organization the company bought out The Doherty Lime Company, which is located near Pemberville, Ohio. The purchase included many acres of a most excellent dolomitic limestone. Many thousands of dollars were spent for the purchasing

H. M. Seibert, General Manager

and installing of new and modern equipment and an "up to date" plant is the result. Electric power is used throughout the entire plant, being equipped with three Bullock power transformers.

The quarry is equipped with one six inch and one five inch centrifugal pump; one six inch geared plunger pump; an Ingersoll-Rand air compressor; a Number 4 Loomis well drill and a Thew steam shovel, which is maintained for the loading of crushed stone. Since The Doherty Lime Company had opened a hole one thousand feet long, four hundred feet wide and twenty feet deep, it is unnecessary to do any stripping, as all of the stone is being quarried from the old hole, which is being lowered to a depth of sixty feet. All of the stone is hand picked, which means that there is a reasonable amount of uniformity in the size and quality of the stone, that is used for burning. The finer stone is forked and hoisted to the crusher building. Here it is run through a Number 5 Gyratory crusher, from where it is conveyed, by means of a large bucket conveyor, to a large revolving screen and sorted into bins, according to size. A large Symons crusher, having a capacity of thirty tons an hour, is also located in this building and is in use, almost constantly.

The kiln stone is taken directly from the quarry to the kilns and after being burned into lime, is put on the floor where it is broken up and allowed to cool; this assures a uniform hydration. From the floor, it is shoveled into a belt conveyor, which feeds it into a Williams hammer mill; this lime is in turn conveyed, by means of a lime elevator, to a large crushed lime bin. From this bin, it is weighed out into a Clyde batch hydrator, where the correct amount of water is measured into each batch. After a thorough hydration, it is dumped into a bin, from where a screw conveyor takes the lime to a Raymond mill. Into this screw conveyor, is fed a certain percentage of grit, which has previously been run through a hammer mill. By means of this method, the lime contains an even amount of grit throughout. This additional operation practically removes all chances of the lime becoming gummy and "bunching up" under the trowel. From this mill, the lime is blown into finishing lime tanks, from where the lime is sacked into fifty pound paper bags.

A 2 by 4 inch shaker screened coal is used for the burning of the lime and a large boiler furnishes the steam, which gives the necessary amount of dampness. During the past year, a trifle over four tons of lime were burned per each ton of coal consumed. An average of sixteen tons of lime are produced, by each kiln, every twenty-four hours.

In recent months the company has perfected a colored finishing lime, that is meeting with great success. Artint is the name, that has been selected for this product. The following colors have been standardized: pure white, light and dark cream, light and dark buff, light and dark brown, mauve, taracotta, light and dark pink, light, medium and dark green light, medium and dark blue and light and dark grey. All colors are absolutely guaranteed against fading in the sunlight.

In the making of Artint, several materials are used, which give it excellent accustic properties, and a most desirable finish for churches, schools, theaters, large auditoriums and the like, is the result. All of this material is run through three different kinds of machines, that are especially adapted to work of this kind. Each ingredient is weighed out to the fraction of an ounce, so that uniform mixtures and colors that will match at all times are assured. Artint is made with or without sand. The

Georger Burket, Plant Superintendent

sanded, of course, is used for sand finishes only while the unsanded is most excellent for all kinds of "Antique" work. It can be put on the wall in any texture desired, from a smooth trowel finish to an exceedingly heavy stipple and it will "set up" in about the same length of time as finishing hydrate lime. Artint can be soaked the same as finishing lime and will not harden in the box as long as it is covered with water. Water will not affect its color in any way. Artint requires no plaster of paris, retarder or any outside ingredient, so that the plasterer may put it on the wall as soon as it is brought to him, from the mortar box. It can be applied on any standard brown coat within twelve to fifty hours after the brown coat has been applied; depending entirely on drying conditions. This saves the contracting plasterer much time and money, on big jobs, as it relieves him of the necessity of tearing down and rebuilding his scaffolding.

Sanded Artint will cover from four hundred to four hundred and fifty yards per ton and the unsanded Artint will cover from five hundred and

Fred Geisbuhler, Quarry Foreman

fifty to six hundred yards per ton, in the "Trowel Finish." Coverage on antique work depends entirely on the thickness of the texture or stipple. Two or more colors may be applied on the same wall, one on top of the other, and as long as the underneath finishing coats are allowed to show through a most beautiful color effect is the result. Most exquisite designs and textures are so easily obtained by the use of Artint that it is within the reach of every average plasterer.

Artint will stand the use of soap and water so that it is most easily cleaned. Different colored washes are also manufactured, by The Ohio Lime and Stone Company, so that if a change in colors is desired at any time, it may be very easily obtained. This wash may be put on with a brush or by means of a spray and it is thoroughly dry five minutes after its application. This last item removes the necessity of having the home, office, church or in fact any building in a state of disarrangement or confusion, for several days, as would be the case if the rooms were to be repapered or repainted.

Artint, in the first ten months of its infancy, has been used on nearly three hundred jobs in one city alone. These jobs include churches, theaters, schools, branch Y. M. C. A.'s, a Masonic Temple, restaurants, bathhouses, clinics, office buildings and homes. This fact alone proves that Artint has met with the approval of all concerned, included architects, plasterers, contractors, buyers, dealers, tenants and well informed critics on interior decorations.

C. C. Greiner is president of the Ohio Lime and Stone Company and F. P. Spitzer is secretary treasurer.

ARTINT (Colored Lime)

A stands for abuse
Artint walls will stand.
Nicks never will show
And walls always look grand.

B is for beauty
By all, it's desired
And by using Artint
The beauty's acquired.

C stands for colors
Nineteen, when all told;
There's plenty to spare,
To suit young and old.

D is for decorating
Powers, all its own;
It will surely beautify
Any building or home.

E is for elegant
Looks, which it owns;
They're always attractive,
In numberless tones.

F stands for finishes
And their colors fast;
Whatever your choice,
The shade's bound to last.

G stands for grandeur
And you must admit,
For interior finish,
Artint surely has "IT."

H is for hardness
And for harmony, too;
Distinctiveness, of Artint,
Will be amazing to you.

I stands for ideal
Shades and styles, too;
We have most a million
And some will please you.

J stands for joy,
That Artint will bring,
To everyone living,
From pauper to king.

K stands for king
Of interior finishes;
It adds attractiveness
And housework diminishes.

L is for luster,
It's always the same;
If finish has luster,
Artint must be its name.

M stands for mystic
Properties, its own,
And for money it saves,
Building, office and home.

N stands for neatness,
So easy to obtain;
It stands soap and water,
Which means death to stain.

O stands for omega,
Which means, "the last" word,
In interior decorations,
When of Artint you've heard.

P is for painting,
That is saved, as you know;
Artint's colored all through,
So chipped places won't show.

Q is for qualities,
Of this colored lime;
Which, when all put together,
Make it look so sublime.

R stands for reduction;
Both in cost and upkeep
And in time saved, in cleaning,
Still it always looks neat.

S is for service,
That Artint gives you
And let us say now,
That it's "Tried and True."

T stands for textures,
Or finishes grand;
We have plain and stipple
And also the sand.

U is for uses,
Both large and small;
Give Artint a chance,
It will satisfy all.

V is for value
Received by the user,
In the using of Artint,
You can't be the loser.

W stands for work,
Saved poor little wife;
Relieving her of worry
'Bout the walls, for life.

X Stands for unknown
Benefits, of this lime.
Of Artint advantages,
You'll learn all the time.

Y is for years,
That Artint will stand;
In every climate
And in any land.

Z stands for zeitgeist,
Meaning "spirit of the age";
Be sure and use Artint,
'Cause it's all the rage.

Illinois Slag Improves

Improvements costing over $100,000 consisting of installment of the most modern machinery for crushing and screening slag, including a 100 ton caterpillar steam shovel, have been completed by the Illinois Slag and Ballast Company of Chicago. The company uses the slag of the Wisconsin Steel Company operations and furnishes material at the rate of 2500 tons per day to the Chicago Surface Lines.

New Feldspar Plant Starts

The new feldspar grinding plant at Spruce Pine, North Carolina, owned by Golding Sons and Company, of Trenton, New Jersey, recently started operations. At present, the capacity is from 80 to 100 tons per day.

Winchester Moves Pit

The Winchester Gravel and Stone Company of Winchester, Indiana, found it necessary to relocate their gravel pit. A Miami scraper with a McCormick Deering tractor was used for stripping the overburden. This overburden was hauled to and dumped at the old pit. In this dumping it was necessary to back the scraper over the edge of the pit and drop the overburden down the slope.

Fluorspar Industry in 1927

Salient features of the fluorspar industry in 1927, as shown by a statement prepared by Hubert W. Davis, of the United States Bureau of Mines, Department of Commerce, are the decrease in domestic shipments, which for the fifth consecutive year recorded a decline; the pronounced increase in the imports from Germany and the equally pronounced decrease in the imports from the United Kingdom; the large stocks of fluorspar at consumers' plants on December 31, 1927, especially the stocks of 85,000 tons that have been accumulated at basic open-hearth steel plants; and the increase in producers' stock-piles, which are also the largest ever accumulated.

The figures on production of fluorspar in Illinois were collected in cooperation with the State Geological Survey.

The fluorspar shipped from mines in the United States in 1927 amounted to 112,546 short tons and was valued at $2,034,728, as compared with 128,657 tons, valued at $2,341,277, in 1926. Thus there were decreases of 13 per cent both in quantity and in total value as compared with 1926. Fluorspar was shipped from Colorado, Illinois, Kentucky, and New Mexico in 1927, but New Mexico was the only state to record an increase.

The reported shipments of fluorspar to manufacturers of enamel and of hydrofluoric acid were more than in 1926, but the shipments to manufacturers of iron and steel and glass were considerably less and the quantity exported was the smallest since 1921.

The general average value per ton f. o. b. shipping points for all grades of fluorspar in 1927 was $18.08, which is 12 cents less than the average for 1926. The general average value of the fluorspar shipped to steel plants in 1927 from the Illinois-Kentucky district was $16.59 a ton and from the Colorado-New Mexico district $13.72 a ton. These values compare with $16.98 for the Illinois-Kentucky district and $12.69 for the Colorado-New Mexico district in 1926. This difference in average values represents rather the difference in freight costs from the mines to consuming centers than differences in quality of fluorspar from these two districts.

According to the reports of producers the stocks of fluorspar at mines or at shipping points on December 31, 1927, amounted to 21,208 short tons of gravel fluorspar, 1,857 tons of lump fluorspar, and 385 tons of ground fluorspar, a total of 23,450 tons of "ready-to-ship" fluorspar. In addition there was in stock-piles at mines at the close of 1927 about 49,000 short tons of crude (run-of-mine) fluorspar which must be milled before it can be marketed and which is calculated to be equivalent to about 29,000 tons of merchantable fluorspar. These stocks compare with 20,731 tons of "ready-to-ship" fluorspar and 48,266 tons of crude fluorspar on December 31, 1926. Thus the stocks of merchantable fluorspar increased about 13 per cent and those of crude fluorspar about 2 per cent over 1926.

The following tables show the details of the shipment of fluorspar by States, by kinds, and by uses for 1926 and 1927.

The following table shows the imports of fluorspar into the United States by countries for 1926 and 1927.

Fluorspar imported into the United States, 1926-1927, by countries, in short tons* (General imports)

Country	1926	1927
Africa:		
British South	7,534	
British West	610	7,069
Portuguese East	362	
Belgium	31	21
Canada	1,109	560
China	645	449
France	11,163	11,711
Germany	20,465	31,829
Italy	1,379	449
Soviet Russia in Asia	18	.....
Spain	2,948	978
United Kingdom	29,407	18,449
	75,671	71,515

*Figures compiled from records of the Bureau of Foreign and Domestic Commerce and those for 1927 subject to revision.

Fluorspar shipped from mines in the United States, 1926-1927, by states

State	1926 Short tons	1926 Value Total	1926 Value Average	1927 Short tons	1927 Value Total	1927 Value Average
Illinois	53,734	$1,012,879	$18.85	46,006	$ 863,909	$18.78
Kentucky	62,494	1,167,129	18.68	57,495	1,040,338	18.09
Colorado	10.440	161,269	12.98	6,432	130,481	18.08
New Mexico	1,989			2,613		
	128,657	$2,341,277	$18.20	112,546	$2,034,728	$18.08

Fluorspar shipped from mines in the United States, 1926-1927, by kinds

Kind	1926 Short tons	1926 Value Total	1926 Value Average	1927 Short tons	1927 Value Total	1927 Value Average
Gravel	112,092	$1,868,854	$16.67	97,036	$1,599,310	$16.48
Lump	5,292	108,710	20.54	4,960	105,062	21.18
Ground	11,273	363,713	32.26	10,550	330,356	31.31
	128,657	$2,341,277	$18.20	112,546	$2,034,728	18.08

Fluorspar shipped from mines in the United States, 1926-1927, by uses

Use	1926 Short tons	1926 Value Total	1926 Value Average	1927 Short tons	1927 Value Total	1927 Value Average
Steel	105,614	$1,744,085	$16.51	93,196	$1,523,915	$16.35
Foundry	6,212	121,453	19.55	4,533	84,724	18.69
Glass	7,507	240,288	32.01	5,968	184,450	30.91
Enamel and vitrolite	3,410	113,445	33.27	3,813	119,888	31.44
Hydrofluoric acid	3,410	79,105	23.20	3,748	98,364	26.24
Miscellaneous	372	7,986	21.47	903	15,880	17.59
Exported	2,132	34,915	16.38	385	7,507	19.50
	128,657	$2,341,277	$18.20	112,546	$2,034,728	$18.08

The total imports of fluorspar into the United States in 1927, amounted to 71,515 short tons, represent a decrease of 5 per cent from the record year 1926, but are the second largest ever recorded. The imports in 1927 are equivalent to 64 per cent of the total shipments of domestic fluorspar, as compared with 59 per cent in 1926.

The United Kingdom, which has been the chief source of the imported fluorspar, supplied only 26 per cent of the total in 1927, the imports of 18,449 tons therefrom representing a decrease of 37 per cent. Germany was the chief source of imports in 1927, supplying 45 per cent of the total. The imports from Germany in 1927 were 56 per cent more than in 1926. France was the only other source from which more fluorspar was imported in 1927 than in 1926.

The figures on consumption of fluorspar in 1926 and 1927 and stocks at consumers' plants at the close of each of these years, given in the following table, while not including data from all consumers, are believed to fall not far short of the total for the United States. Thus, the figures for the basic open-hearth steel industry, the chief consumer of fluorspar, include actual figures for the 72 companies that make 99 per cent of the total basis open-hearth steel and estimates for the other three companies. Consumption by all electric-steel and ferro-alloy manufacturers that are known to use fluorspar is accounted for. The smaller foundries, some of which use a little fluorspar, are not all represented, so that the figures for this industry are somewhat incomplete. The figures for fluorspar used

Industry	1926 Consumption	1926 Stocks at consumers' plants Dec. 31	1927 Consumption	1927 Stocks at consumers' plants Dec. 31
Basic open-hearth steel	142,000	70,000	138,000	85,000
Electric-furnace steel	4,800	2,000	4,700	1,200
Foundry	4,335	1,400	3,400	1,000
Ferro-alloys	462	180	500	100
Hydrofluoric acid and derivatives	7,591	12,153	15,500	13,000
Enamel and vitrolite	6,677	935	5,800	800
Glass	7,973	1,342	6,800	900
Miscellaneous	719	252	1,500	400
	174,557	88,262	176,200	102,400

in manufacture of hydrofluoric acid for the two years are not comparable, those for 1927 representing six companies, whereas the figures for 1926 represent only five companies. The consumption and stocks for the glass and enamel industries, although not covering all consumers, represent 117 companies. These companies include all of the larger and probably most of the smaller consumers, so that the figures for these two industries are believed to be practically complete.

Producers Accept Plan of Agriculturists

Negotiations between the Illinois Agricultural Association and 16 leading limestone companies for supplying agricultural limestone were completed at a joint meeting on March 15, in the offices of the association. The plan contemplates the pooling of orders by purchasers and allows the Farm Bureau members a 10 per cent differential, reflected in a refund, rather than a lower purchase price as heretofore.

Oregon Lime Plant Opens

The Lime Products Company is opening a plant at Falls City, Oregon, for the purpose of producing ground limerock for use on the farm. The railroad track for transporting the product has been laid to the plant. Considerable work has been done at the quarry and material and equipment is on the ground for building the plant.

Largest Blast for Ohio

What is said to be the largest blast ever detonated in the State of Ohio, occurred March 24, 1928. Plans for the blast were consummated by R. N. Van Winkle, general manager of the American Crushed Rock Company at White Sulphur, and Le Roy Keane of the Hercules Powder Company, in which 4,800 pounds of explosives were placed in 384 holes and ignited. It is said that 11,500 tons of limestone were disrupted by the blast.

Eureka Makes Concrete Units

The Eureka Silo Company of North Manchester, Indiana, operates a gravel pit on the Liberty Mills Road. It has recently started the manufacture of silo slabs, concrete blocks and brick. The company is headed by S. A. Noftzger and Dayton Huffman.

Stearns Changes Offices

The Stearns Lime and Stone Company announces the new address of its office at 105 West Adams Street, Chicago. It will occupy Suite 1633 and the phone is Dearborn 8446.

Ohio Sand Producers Organize

The Ohio Sand and Gravel Producers, consisting of 30 operators on the Ohio River between Pittsburgh and Cincinnati, met in Huntington, West Virginia, March 28, and organized an association. C. C. Patterson of the Iron City Sand and Gravel Company and the Ohio River Sand and Gravel Company of Parkersburg, was elected president; F. E. Hall of the Hall Sand and Gravel Company of Cincinnati, vice-president; J. L. Richmond of Huntington, secretary-treasurer. Other members of the board are Albert E. Frosh, Liverpool, Ohio; G. E. Debout, Zanesville, Ohio; S. M. Gallagher, Charleston, West Virginia; William Stump, Wheeling, West Virginia; and G. B. Suitor, Manchester, Ohio.

Chicago Firm Purchases Sand and Gravel Pit

The M. R. Gibbons Company of Chicago has purchased a large deposit of gravel near Cherokee, Iowa. The pit which was purchased from E. E. Lyman is located near the tracks of the Illinois Central Railroad.

Frontz Sponsors New Company

Lee A. Frontz for several years engaged in prospecting and mining operations, has formed the Pacific Rock Company to operate at Centerville, California. Mr. Frontz was the organizer of the California Rock Company, which has pits near Elliott which have been operated successfully for several years.

Harrison Buys Concrete Plant

E. W. Harrison of the Harrison Company has purchased the property of the Graystone Concrete Company at Tacoma, Washington. Mr. Harrison will conduct the business as an individual, it is announced, and retained E. L. Warher as manager.

Pit and Quarry Expands

Fifty per cent more space has been added to the office of Pit and Quarry in the Rand McNally Building, Chicago. This additional space was necessary to facilitate the increasing service to our readers.

Those who make a habit of dropping in for a chat when in Chicago will notice some radical changes in our layout. It is a good thing to make a point of calling at the Pit and Quarry office when in Chicago for information, help or a chat.

A. R. B. A. Appoints C. N. Conner Chief Engineer

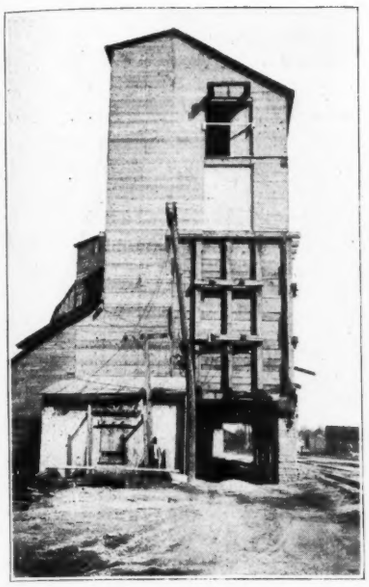
The American Road Builders' Association announces that Mr. C. N. Conner, of the Highway Research Board, has been retained as chief engineer of the association.

The association is to be congratulated upon securing the services of Mr. Conner, who has had wide experience as a road builder and exceptional experience as a committee worker. He has recently been chairman of the committee on Low Cost Improved Roads, operating under the Highway Research Board. Mr. Conner was graduated from Tufts College in 1908. For three years he worked as engineer in railroad construction, and later was assistant engineer with the Bureau of Public Roads in the Philippine Islands. His next position was assistant engineer with the War Department and then with the Navy Department. He then became assistant engineer with the Delaware State Highway Department, and after that was State Construction Engineer for the North Carolina Highway Commission, where he was also head of the testing and research laboratory for a brief period. During 1925 and 1926 Mr. Conner was chief engineer of the Mexican Federal Highway Commission. He is a member of several technical organizations and author of many articles which have appeared in technical publications.

Mr. Conner's work for the present will consist of co-ordinating the activities of the committees of the several divisions and arranging for the committee reports which will constitute the program of the next convention. The County Highway Officials' Division, the Highway Contractors' Division and the City Officials' Division will operate through committees and their reports from the basis of the program for the next convention.

The American Road Builders' Association will organize in addition to its present committees several committees that will deal with problems of national interest. The program for the 1929 convention of the association will consist essentially of reports of the chairmen of the various standards committees. These reports will represent the work of the committees during the entire year, and every effort will be made to present them in a manner that is clear, interesting and concise.

The retaining of Mr. Conner as chief engineer of the association marks another step in the development and usefulness of the association.



South View of Plant

Tarbox McCall Rebuilds Plant

The crushed stone plant of the Tarbox McCall Company is located within the City of Findlay, Ohio, on Western Avenue, on a switch of the N. K. P., formerly the L. E. and W. Railroad. The location of the plant makes it easily accessible and much of the stone is trucked from the plant to the customers which causes the trend of market demands to be readily obtainable.

It has been the policy of the company to study the requirements and demands of the immediate vicinity and arrange to meet the need as it arises. The increasing demand for small sizes indicated that it was necessary to produce them and since the plant had been built up from time to time as demand regulated it was found necessary to inaugurate a rebuilding program.

In rebuilding the plant, the company not only enlarged the bin for storing agricultural sand, but constructed additional bins for the other small sizes. This gave the additional space necessary to store surplus and meet the seasonal demands for such sizes as required by the trade.

New elevator equipment has been installed together with a double deck vibrator screen and the necessary auxiliary equipment. The grates in the American pulverizer were changed to permit the making of a greater variety of sizes. By speeding up the equipment, it is possible not only to produce the desirable sizes, but to increase the output of smaller sizes.

It is the object of the company to make a more satisfactory product with greater speed and have it more accessible to the trade. The agricultural sand is more uniform in character and better adapted to the needs of the consumer. The changes which have been made are those which stone producers have found necessary to keep in line with the progress of the manufacture of crushed stone products as time and new uses of material require adjustment to the need of the immediate markets.

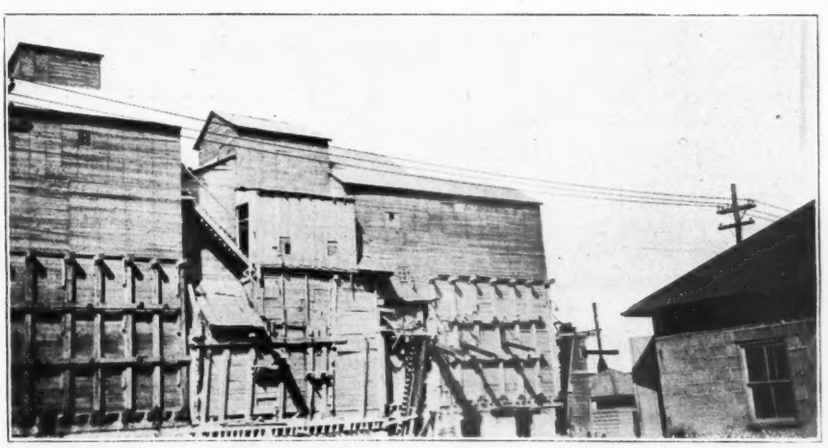
South and East View

Iowa Firm Purchases Bethany Quarry

The Concrete Materials Company of Waterloo, Iowa, has purchased a quarry at Bethany, Missouri. It is stated that the purchasers expect to use the crushed rock on Iowa highways and, in addition, two quarries are to be opened in Iowa.

North and East View of Tarbox McCall Plant

View of Tarbox McCall Quarry



East View of Tarbox McCall Plant

Magnesite in 1927

The production of crude magnesite in the United States in 1927 was 121,490 short tons, valued at $1,090,550, according to statistics compiled by J. M. Hill, of the United States Bureau of Mines, Department of Commerce. Three operators working 3 mines, one each in Santa Clara, Stanislaus, and Tulare counties, in California produced and sold 43,750 tons of crude magnesite, valued at $507,500. All of the output in Washington was from the mines of the Northwest Magnesite Co., which produced dead-burned magnesite at Chewelah. Two of its 6 furnaces were operated only part of the year.

Magnesite supply in the United States, 1922-1927, expressed as crude magnesite, in short tons

Year	Domestic	Imported	Total
1922	55,790	217,861	273,651
1923	147,250	151,092	298,342
1924	120,100	148,700	268,800
1925	120,660	142,283	262,943
1926	133,500	196,318	329,818
1927	121,490	149,126	270,616

(1)Prior to 1924 a factor of 2 tons of crude to 1 ton of calcined was used in expressing imports as crude magnesite. Since 1924 the factors used are 2 to 1 for imports from Italy and 2½ to 1 for other imports.

Sales of magnesite of domestic origin in 1927 were 1,800 tons crude, 13,890 tons of caustic calcined (a decrease of 25 per cent as compared with 1926), and 40,210 tons of dead-burned (a decrease of 5 per cent as compared with 1926), having a total value of $1,460,240.

Domestic supply of magnesite in various forms in 1927

Class	Sales (domestic) Short tons	Sales (domestic) Value f.o.b. mine	Imports Short tons	Imports Declared Value	Total Short tons	Total value
Crude ..	1,800	$ 17,130	891	$ 9,790	2,691	$ 26,920
Caustic	13,890	452,810	9463	229,592	23,353	682,402
Dead-burned	40,210	990,300	49,873	727,881	90,083	1,718,181

Imports of magnesite in 1927, according to the Bureau of Foreign and Domestic Commerce, were 891 short tons crude, valued at $9,790, of which 88 per cent came from Greece; 9,463 tons of caustic calcined, valued at $229,592, of which 60 per cent from India and 33 per cent from the Netherlands; and 49,873 tons of dead-burned, valued at $727,881, of which 75 per cent was from Austria and Czechoslovakia. Corresponding figures for 1926 are 608 tons of crude, valued at $6,555; 14,830 tons of caustic calcined, valued at $330,131; and 77,108 of dead-burned, valued at $1,128,823.

Quotations on crude magnesite during 1927 were $14 a ton. California Grade A, caustic calcined, ground 80 per cent through 200-mesh, was quoted at $40 a ton throughout the year and Grade B at $38 a ton. Dead-burned was quoted at $33 a ton, f.o.b. California mines, until the first of November, when the price was reduced to $30 to $32 a ton. Quotations, f. o. b. eastern seaboard, were $40 a ton throughout the year.

Domestic producers reported sales of crude magnesite at from $7.50 to $13 a ton, f. o. b. shipping point of mine, and the average price for all magnesite sold crude was $9.52 a ton. Producers of caustic calcined magnesite in the United States reported sales at from $30 to $34 a ton, the average price for the total sales of domestic being $32.60 a ton. Domestic dead-burned magnesite was sold at from $24 to $29 a ton, the average price for the entire output being $24.63 a ton, f. o. b. shipping point.

Producers reported stocks of 6,150 tons of crude magnesite at plants on December 31, 1927.

By proclamation, under the Tariff Act of 1922, the President of the United States on November 10, 1927, increased the rate of import duty on magnesite as follows: Crude magnesite from 5/16 to 15/32 cents per pound (from $6.25 to $9.375 a short ton); caustic calcined magnesite from 5/8 to 15/16 cents a pound ($12.50 to $18.75 a short ton).

New Incorporations

Missouri Asphalt Corp., Sheldon, Mo., $1,500,000. J. E. and E. R. Henderson, Sheldon. E. Pearce, Imperial Hotel, 32nd St. and Broadway, New York City; C. R. Skinner, Drexel Bldg., Philadelphia, Pa.

White Plains Asphalt Co., White Plains, Ky. $50,000. Elmer E. George, Proctorville, O.; G. V. George, 15700 Petoskey Ave., Detroit, Mich.

E. Wunderlich Granite Co., 804 N. Hickory St., Joliet, Ill. $60,000.

American Silica Corp., Ottawa, Ill. $363,000 and 50,000 shares n. p. v. (Merger of several Ottawa district silica companies).

Iowa Lime Rock Corp., Oskaloosa, Iowa. $50,000. Quarrying and crushing plant near Tracy, Iowa. Harry W. Harding.

St. Charles Lime & Quarry Co., St. Charles, Mo. $25,000. Charles Hahn.

Dinero Sand & Gravel Co., 144 Adams St., Brownsville, Tex. Clarence Owens, Mgr.; John Gregg; H. G. Gay.

Builders' Sand & Gravel Co., Seattle, Wash. $50,000. Ray F. Wood. (Bought Superior Sand & Gravel Co.)

New River Lime Co., Inc., Ripplemead, Va. $25,000. Bernard Mason, Pearlsburg; Clay Mason, Ripplemead.

Feldspar Milling Co., Burnsville, N. C. $500,000. J. L. Hyatt, Burnsville; C. B. Hyatt, 69 Edwin Place, Asheville; J. F. Shinn, Norwood.

Quincy Crushed Stone Co., Boston, Mass. $50,000. Daniel P. Kelley, Pres.; Nicholas Russo; Thomas D. Russo, Treas., 75 Bradeen St., Roslindale.

Lassiter-Davis Glauconite Co., 6314 First Ave., Birmingham, Ala. $25,000. W. S. Davis. To develop glauconite deposits.

Bechtel-Kaiser Rock Co., San Francisco, Calif. $500,000. R. K. Bechtel, T. M. Price, S. McWhorter, Paul S. Marvin, G. W. Sherwood.

Arrowhead Granite Co., Hibing, Mont. $50,000. D. Soderstrom, A. F. Anderson.

Riverhead Cement Block Co., Riverhead, N. Y. $25,000. Raymond Corwin, Pres.; George Hawks, V. P. & Gen. Mgr.; C. H. Young, Treas. To produce sand and gravel and manufacture cement blocks.

Belmont-Gurnee Stone Corp., Suffern, N. Y. 2,000 shares com. R. B. Altschuler, Hackensack, N. J.

Chicago Architectural Stone Co., 1906 S. Western Ave., Chicago. Walter S. Bell, Harry Platt, N. B. Taylor. $40,000.

P. Grassi & Co., San Francisco, Calif. $500,000. W. R. Lowery, Carlo Tricoli, S. Andriano, Penzo Turco, P. Buddington. Travertine quarry.

Blue Rapids Gravel Co., Holton, Kans. $50,000. Ed. Grundeman, Otto Grundeman, W. R. Canfield, Frank Paul, F. L. Rieder.

Empire Granite Co., Elberton, Ga. $15,000. O. Minervini, Relix Solana, H. H. Stoner.

Standard Sand & Gravel Co., Fort Smith, Ark. $9,000. J. W. Hood, W. B. Pattison, W. E. Harrell.

Taft Sand & Gravel Corp., Northville, Mich. $10,000.

American Limerock Corp., Savannah, Ga. $50,000. Frederick A. Von Eberstein, Barton A. Horswell, P. A. Horswell, M. O. Dunning, F. M. Oliver. Quarry at Cordele, Ga.

NEWS OF EQUIPMENT MANUFACTURERS

Waukesha Motor Announces New Gas Mixer

"Gaspower" is the trade name of the new automatic compensating gas mixer for internal combustion engines, which is being made and marketed by the Waukesha Motor Company of Waukesha, Wisconsin.

This company has long been known in the industrial power field as the builder of heavy duty gas and gasoline engines. Their product is today found driving machinery in every part of the world, pumping water, compressing air, harvesting and threshing grain, excavating canals, building roads, mixing concrete, and, in fact, every kind of duty to which this convenient and simple type of power is applied.

This latest device was created to satisfy the insistent demand for a reliable gas proportioning device, needed both here and abroad, in the oil industry. Much of the power that is used in the production of oil is from natural gas. The gas engine is the simplest means of converting this abundant, cheap fuel into efficient power.

When a recent survey disclosed Waukesha engines to be pumping more than ten per cent of the world's production of petroleum, the necessity for a reliable, sensitive and economical gas mixing valve was most apparent.

"Gaspower" handles with equal facility, "still," natural or artificial gas, and offers a degree of control impossible with any other "gas carburetor."

Its principal features are: Great responsiveness — instantly and automatically proportioning the fuel and air at every change of speed or load; high economy because of perfect mixtures over a wide range of demands; elimination of volume tank, substituting a sensitive regulator; no hair trigger adjustments continually required; and, unlike any others, its best operation requires low gas pressure.

Gas Engine Driven Welder

To meet the growing demand in work of all kinds, The Lincoln Electric Company announce the new model of the "Stable-Arc" welder, known as the S-1960 Model. The unit has a rating of 200 amperes according to N. E. M. A. standards, with a current range of welding duty of from 50 to 300 amperes, and operates at a speed of 1500 r. p. m. Motive power is provided by a four cylinder Continental Red Seal Engine, type H-9.

The welding generator and engine are mounted on a structural base welded into a solid piece of steel. This welded steel base provides a maximum stiffness and rigidity with the whole unit weighing only 150 pounds and being only 76 inches long by 25 inches wide. The generator is constructed of steel, reducing the weight and the possibility of breakage in the field.

The complete magnetic circuit of the generator is of laminated steel structure, thus increasing the stability of the arc because many times welding must be done in a vertical plane and frequently overhead. A steel switchboard is also provided, thus still further reducing the possibility of damage in the field.

Hazard Wire Rope Licensed To Use Preform Method

Several years ago, American Cable Company, Inc., introduced an important improvement in the design and manufacture of steel wire cable. The strands and wires of the cable are preformed. The product is now widely known under the trademark "Tru-Lay Preformed Wire Rope." A new type of fitting has also been developed which is known and advertised as "Tru-Loc Processed Fitting."

The Hazard Wire Rope Company of Wilkes-Barre, Pa., has been given a license to manufacture this type of rope and fittings. The Hazard Wire Rope Company has for many years been recognized as a manufacturer of wire rope of the highest quality and is probably the oldest manufacturer in its line in the United States.

The economic value of preformed wire rope is now internationally recognized, as is evidenced by the fact that licenses have been granted by American Cable Company, Inc., to the following manufacturers: Dominion Wire Rope Company, Ltd., Montreal, Canada. Bruntons, Musselburgh, Scotland, for Great Britain. Felten & Guilleaume Carlswerk, Cologne, Germany, licensed for the continent of Europe and have sub-licensed other manufacturers in European countries.

The Mideke Supply Co., 100 East Main St., Oklahoma City, Okla., has recently been appointed to represent Foote Bros. Gear & Machine Co. on their line of IXL Speed Reducers, Gear Products and general transmission machinery, in Oklahoma City and vicinity.

New Economy Pump

As a companion to its new line of double suction single state pumps, the Economy Pumping Machinery Company, has placed on the market several sizes of hydraulically balanced multi stage centrifugal pumps. These pumps have been especially designed for boiler feeding, city water works and other heavy duty high pressure service. Discharge pressures range from 100 pounds to 500 pounds per square inch.

These new pumps are of the single suction design without diffusion rings but with a spiral or volute in every stage. This design makes possible an efficiency which approaches that of single stage pumps. (In the ordinary design there is a large loss of head between stages which very materially reduces the efficiency.)

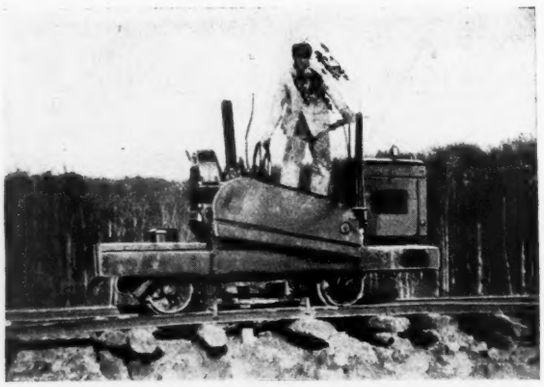
Solid bronze one piece diaphragms are used between stages. These diaphragms are tongued and grooved in the case so that there can be no leakage between the case and the diaphragm. The use of the one piece diaphragm does away with leakage between stages which sometimes occurs as a result of the case joint separating under high internal pressure. In the Economy design the length of gasket held by each bolt is very short.

The Hydraulic balancing device is of the disc type located at the outboard end of the pump. Leakage at the high pressure stuffing box is controlled by a needle valve on the water seal. Stuffing glands are both of bronze of the split type designed to deflect leakage into the bearing yoke. Shaft sleeves are grooved to throw the leakage within the gland preventing water throwing. Bearings are of the ring oiling type sealed to prevent the escape of oil or entry of dirt or water. Bearing shells are case iron babbitt lined. They are supported in brackets cast with the case and are fitted with spring oil hole covers and oil level cups. The pump shaft is of high carbon alloy steel turned and ground all over and threaded on centers. It is protected wherever exposed to the water by bronze shaft sleeves extending through the stuffing boxes.

In these new pumps the heads per stage is kept quite low in order to secure maximum efficiency with low water velocities. The result is a pump which has a very light rotating element and which has very flat horse power and efficiency curves. The low water velocities insure very long life and low maintenance cost.

A New Narrow Gage Track Shifter

Those who have narrow gage track to shift and raise will welcome the announcement of the Nordberg Manufacturing Company of Milwaukee, of a new Model "O" Track Shifter, a machine that can now be procured for use on track as narrow as 36 inch gage. This company for the past



three years has been building a standard gage machine. While it is the only piece of equipment of its kind on the market, after it became generally known of the great saving in time and labor that could be accomplished with its use, there were many demands for a similar machine suitable for narrow gage work. In fact, the demand was so insistent from several users who had standard gage machines and who maintained both standard and narrow gage track, that a few of the larger machines were reconstructed for a narrow track before the design of the new model could be completed.

The principle of operation of the Model "O" is the same as that of the standard machines. Due to a less severe service and smaller dimensions, it has been possible to simplify the controls and decrease the weight in comparison with the larger machine. It is powered by a 4 cylinder, 15 h.p., fully enclosed gasoline unit. There are two propelling speeds in either direction—a low of 4½ miles and a high of 13 miles. The worm driven lifting speed has a lifting capacity of 42,000 pounds at a maximum lifting speed of 15 feet per minute. The frame is made of 8 inch channels and all the joints are welded, has a width of 5 feet 5 inches, length of 12 feet 1 inch, and a wheel base of 5 feet 5 inches.

Power for the various functions of the machine is supplied through friction disc clutches. Any clutch to be in service must be held in by the operator—that is, when the clutch is released, it is automatically disengaged. This arrangement permits a much faster performance as it enables the securing of greater accuracy in the various movements of the machine when shifting and raising track.

While this machine is principally for shifting work, it can also be used for raising track by lifting one rail at a time. This dispenses with the track gang and greatly speeds up any track raising job.

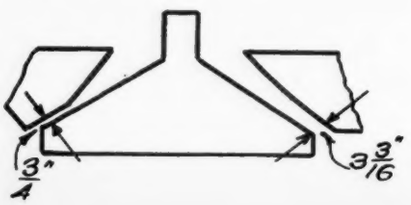
At quarries, open pit mines, construction jobs, or any place where narrow gage track must be shifted and raised on waste dumps and fills, this new Model "O" Track Shifter will equal in every way the performance of its larger companion machine, the Model "H." The operator and several laborers will replace the usual track gang resulting in saving labor and faster work. Shifting and raising track by hand is sometimes a difficult task, especially when working in mud, sand, cinders, slag, or other loose material. Such conditions are not a hindrance to the track machine.

Crusher Openings and Fineness

By G. D. Leopold

There seems to be a great deal of confusion in the minds of the users of crushers for producing fine material, as to what sizes of stone can be made when a crusher has certain sized openings.

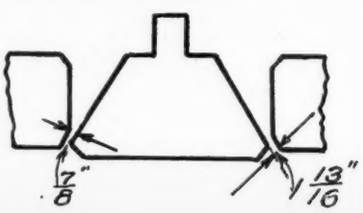
With two different types of fine crushers as shown in the following sketch, the narrow opening in both types, is about the same as the crusher head swings to the left, but the opening on the wide side in one case is 1.75 times as great as in the other case.



With the machine having the greater opening on the wide side, there is a flatter slope to the head which is presumably for the purpose of slowing up the fall of stone, with the idea that the crusher head will deliver several blows before the stone falls out of the crushing zone. While this may be the tendency on the wide side, this flat slope has the effect on narrow side of holding the stone back so long that the production of dust is greatly increased beyond that produced by the other type of crushers.

It is very clear that the fineness of material cannot be estimated by merely considering the minimum size of opening at the bottom of the movable head; the maximum opening must also be considered. The amount of dust which is usually a clear waste product, is also a function of the size of openings as well as the slope of the crushing head.

A proper understanding of these factors will enable the operator to determine what sizes of stone he may expect to secure, and also the amount of waste material which he will produce.



New S-A Offices in Canada

Following the establishment of a complete manufacturing plant at Belleville, Ontario, the Stephens Adamson Manufacturing Company of Canada, Limited, has opened branch sales engineering offices at Toronto, Ontario, and Montreal, Quebec. The Toronto, Ontario office is located in the Bank of Hamilton Building, with Mr. A. F. White in charge. Mr. George H. Smith is in charge of the Montreal, Quebec office, located in the New Birks Building.

For Men in a "Rush"

Ingersoll Rand is distributing an illustrated, 12 page bulletin which is headed with the statement, "This book is for men who are always rushed." It is in keeping with this season of the year and intended as a ready equipment reference and data sheet for those firms which have large contracts and are in need of such information as is contained in the bulletin. The company publishes specific literature and data which concerns special work in the construction field.